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U.S. METRIC STUDY
INTERIM REPORT

A HISTORY OF THE METRIC SYSTEM CONTROVERSY IN THE UNITED STATES

U.S. METRIC STUDY

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SP 345-10

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The results of substudies of the U.S. Metric Study, while being evaluated for the preparation of a comprehensive report to the Congress, are being published in the interim as a series of NBS Special Publications. The titles of the individual reports are listed below.

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U.S. METRIC STUDY INTERIM REPORT

A HISTORY OF THE METRIC SYSTEM CONTROVERSY IN THE UNITED STATES

Tenth in a series of reports prepared for the Congress

U.S. METRIC STUDY
Daniel V. De Simone, Director

Charles F. Treat, Historian

National Bureau of Standards
Special Publication 345–10

UNITED STATES DEPARTMENT OF COMMERCE
MAURICE H. STANS, *Secretary*
NATIONAL BUREAU OF STANDARDS
LEWIS M. BRANSCOMB, *Director*

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LETTER OF TRANSMITTAL

THE HONORABLE PRESIDENT OF THE SENATE
THE HONORABLE SPEAKER OF THE HOUSE OF REPRESENTATIVES

SIRS:

I have the honor to present the tenth in the series of interim reports stemming from the U.S. Metric Study, prepared by the National Bureau of Standards.

This Study was authorized by Public Law 90-472 to reduce the many uncertainties concerning the metric issue and to provide a better basis upon which the Congress may evaluate and resolve it.

I shall make a final report to the Congress on this Study in August 1971. In the meantime, the data and opinions contained in this interim report are being evaluated by the Study team at the National Bureau of Standards. My final report to you will reflect this evaluation.

Respectfully submitted,

Maurice H. Stans

Secretary of Commerce

Enclosure

LETTER OF TRANSMITTAL

Honorable Maurice H. Stans
Secretary of Commerce

Dear Mr. Secretary:

I have the honor to transmit to you another interim report of the U.S. Metric Study, which is being conducted at the National Bureau of Standards at your request and in accordance with the Metric Study Act of 1968.

The Study is exploring the subjects assigned to it with great care. We have tried to reach every relevant sector of the society to elicit their views on the metric issue and their estimates of the costs and benefits called for in the Metric Study Act. Moreover, all of these sectors were given an opportunity to testify in the extensive series of Metric Study Conferences that were held last year.

On the basis of all that we have been able to learn from these conferences, as well as the numerous surveys and investigations, a final report will be made to you before August 1971 for your evaluation and decision as to any recommendations that you may wish to make to the Congress.

The attached interim report includes data and other opinions that are still being evaluated by us to determine their relationship and significance to all of the other information that has been elicited by the Study. All of these evaluations will be reflected in the final report.

Sincerely,

Lewis M. Branscomb

Lewis M. Branscomb, *Director*
National Bureau of Standards

Enclosure

FOREWORD

Almost two centuries of debate have attended the metric question in this country. Thomas Jefferson and John Quincy Adams were embroiled in this controversy. It is yet to be resolved.

This report is an account of the metric system controversy in the United States and is based upon a wide survey of available historical data.

The author of this volume is Mr. Charles F. Treat of the National Bureau of Standards. In an appendix to this report, Mr. Treat acknowledges the assistance he received from many individuals during his research.

Reports covering other substudies of the U.S. Metric Study are listed on the inside front cover. All of these, including this report, are under evaluation. Hence, they are published without prejudice to the comprehensive report on the entire U.S. Metric Study, which will be sent to the Congress by the Secretary of Commerce in August of 1971.

Daniel V. De Simone, *Director*
U.S. Metric Study

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I. INTRODUCTION

Historical precedents have often been a prominent feature of the debate on weights and measures in the United States. In fact many of the reasons why the metric system and its adoption became a hotly-contested issue are deeply rooted in the origins and development patterns of both it and the customary system. The purpose of this introductory chapter is to set the scene for a deeper examination of this issue by summarizing the elements common to all systems of measurement and by briefly reviewing the origins and evolution of the two measurement systems which emerged as the chief competitors for acceptance by the people of the United States.

A. THE BASIC ELEMENTS: MEASUREMENT UNITS, STANDARDS, AND SYSTEMS

An important fact to bear in mind is that all systems of measurement, however much they may differ from one another in detail, stem from a common set of fundamental concepts. The need to measure and the objects to be measured are considerations which are independent of how the measurement is to be taken and described. As will be seen, a failure to distinguish between what a measurement system should *do* and what it should *be* led to a good deal of unnecessary dispute in considering the metric system in the U.S. Also on several occasions the precise meanings of the fundamental concepts were not adhered to by the participants in the debate. This frequently led to confusion when questions arose concerning the impact on the U.S. of changing our measurement system. Therefore, before getting into the heart of the question these concepts need to be established and the distinctions between them clarified.

"Measures and weights" observed John Quincy Adams, "are the instruments used by man for the comparison of quantities and proportions of things [1]." The core of this definition is the concept of quantities—those abstractions such as length, weight, time, and temperature which cannot be described in terms of anything simpler. Collectively they take in all of the characteristics possessed by physical things which someone may wish to express in numerical terms.

For each of these quantities there must be a *unit*, or value in terms of which the quantity may be described [2]. Adhering to the language of the customary system for the moment, examples of units include the "yard" (for describing length), the "pound" (for describing mass), and the "second" (for describing time). Units are simply definitions. They are usually established by general agreement; they are independent of environmental influences (such as temperature and humidity); and they may be arbitrary, that is, they may be selected without reference to any natural occurrence or object [3].

In addition to designating principal units, multiples and subdivisions have been developed for convenience in expressing larger or smaller amounts of a particular quantity. For instance, a yard may be converted into rods or miles or it may be divided into feet or inches by simply applying appropriate numerical factors. These factors define the "base" of a measurement system, so that systems in which the unit is related to its parts by the ratio of 1:10 are termed "decimal" systems and those having the ratio of 1:12 are termed "duodecimal," and so on.

A *standard* is a physical embodiment of a unit [4]. Standards are rarely used to make direct measurements, but they do provide the basic reference point for the manufacture and calibration of the instruments that are used for such purposes. In this way standards insure that the results of many measurements of the same quantity, made by different people at different times, are compatible with each other by virtue of the fact that "things equal to the same thing are equal to each other [5]."

Because standards are physical artifacts, they are exact representations of units only under a set of precisely-defined conditions. As a simplistic illustration, consider the example of a steel rod which someone may desire to fix as his standard of length. If this rod has a length equal to one yard at a temperature of 0° Fahrenheit, it will have a significantly different length at 150° Fahrenheit because steel contracts at the low end of the temperature scale and expands at the high end of it. In order for this steel rod to serve as a true one-yard standard, then, the temperature at which it has the exact length of the unit as defined (in this case, 0° F.) is one of the conditions which must be specified.

The term *measurement system* can have several different meanings, depending upon whether it is being used to denote an abstract concept or an operating entity. For purposes of this account the term is used in its general sense to mean simply a family of units and standards which, together, provide the basis for measuring and describing measurements of length, weight, time, temperature, capacity and all other quantities.

B. THE ORIGINS AND DEVELOPMENT OF MAJOR SYSTEMS OF WEIGHTS AND MEASURES

The conceptual origin of weights and measures is so old that it cannot be precisely fixed. Nor did the development of systems of weights and measures take a simple, ordered course from ancient times down to the present day: "Ethnic conditions, the whims and caprices of rulers, imposition and fraud, conquest, and methods and habits of thought and life, all in turn have had their effect," wrote two authorities in 1906 [6]. Nevertheless, by the middle of the 19th century two systems of weights and measures had attained predominance throughout the world—the English/American customary system and the so-called French metric system. A brief survey of where these two systems came from, how they evolved, and why they managed to achieve such prominence is important background information for considering the history of the metric system in America.

1. ANCIENT WEIGHTS AND MEASURES

The idea that weights and measures were among the earliest devices invented by mankind is generally conceded by historians of metrology who base their conclusions on the fact that the archaeological records of the most ancient civilizations exhibit well-developed concepts of weighing and measuring [7]. It is also generally agreed that the need to measure length preceded the need to measure weight, volume, area and other quantities. Turning once again to John Quincy Adams, whose logic and powers of expression have lost none of their persuasiveness since 1821, we find the case for this latter hypothesis reasoned as follows:

"The want, at least, of measures of length, is found in the physical organization of individual man, and precedes the institution of society . . . To provide for the wants of food and raiment, the first occupation of his life would be the chase of those animals, the flesh of which serves him for food, and the skins of which are adaptable to his person for raiment. In adapting the raiment to his body, he would find at once, in his own person, the want and the supply of a standard measure of length, and of the proportions and subdivisions of that standard. . . .

To the construction of a dwelling place, superficial measure becomes essential, and the dimensions of the building still bear a natural proportion to those of its destined inhabitants. Vessels of capacity are soon found indispensable for the supply of water; and the range of excursion around the dwelling could scarcely fail to suggest the use of a measure of itinerary distance [8]."

With the emergence of civilization from this primitive state, and particularly with the development of complex societies, came the need not only to weigh and measure more things but also to establish uniformity of measurements in order to achieve society's purposes. The origination of ordered systems of enumeration and mathematics made possible the creation of systems of measurement suited to trade and commerce, building construction, land division and taxation.

Although theories concerning the geographical origins of such systems of weights and measures abound (many of which are contradictory), ancient Babylon and Egypt usually share the credit [9]. Archaeological remains prove beyond a doubt that by the time of the great Mesopotamian civilizations (prior to 3000 B.C.) and certainly by the time ancient Egypt's impressive temples and pyramids were built (between 3000 and 1800 B.C.), systems of measurement had become an integral part of daily life [10].

The ancient units of linear measurement were descriptive of what was to serve as the standard in many cases, and also exhibited a naturally-ordered ratio between the multiples and subdivisions. Among these units were the digit (the width of a finger); the palm (the width of 4 fingers, i.e., 4 digits); the span (the spread between the outstretched thumb and little finger, equal to 3 palms); the cubit (distance between the elbow and the tip of the middle finger, equal to 2 spans or 6 palms);[1] the pace (one step, or 10 palms); and the fathom (the distance between outstretched arms, or 4 cubits) [11]. While these measures were rudimentary in comparison with the standards needed by present-day science and technology, they were sufficiently accurate to permit construction of the Great Pyramid of Khufu with an estimated mean error in the length of the sides of only one part in 4000 [12]!

Weighing was a different matter. For most commercial dealings, ancient people either employed measures of volume which were derived from their length units or simply counted the number of items to be traded [13]. At least in ancient Egypt, weights were used only when dealing in precious commodities such as gold, silver, copper, and lapis lazuli [14]. As it was not until the seventh century B.C. that coined money was used, this weighing process was important and the balance was required to be employed in all transactions involving such commodities [15]. Even following the establishment of coinage a very close connection with weight measures was maintained. In fact, the earliest coins were simply pieces of gold or silver with the weight stamped on them [16]. Eventually the Mesopotamian weight unit, the "mina," and its larger and smaller values the "talent" and the "shekel" became the nucleus of a monetary system that spread throughout the whole Mediterranean area [17].

Our modern reckoning of time and method of measuring angles may be traced directly to ancient Mesopotamia, where a sexagesimal system (i.e. based on the number 60) was used to divide not only the year and the day, but also the circle. The year was based on a lunar calendar containing 360 days, and each day was divided into a total of 360 parts [18]. Babylonian astronomy was apparently sophisticated enough to ascertain that, at the equinox, the diameter of the sun on the horizon was 1/360 of a half circle and, as this meshed perfectly with their system of enumeration, it was a natural thing

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[1] This was known as the "common" cubit. There were several other cubits, however, including the Royal or building cubit (28 digits or 7 palms) that served as the basis for the pyramids and many other constructions throughout the Middle and Near East.

to adopt [19]. The solar year of 365 days was the product of Egyptian astronomy, and our modern calendar is the result of that plus later refinement and calendar reform [20].

Judging from admonitions contained in the Old Testament, the commercial uses of weights and measures were not always uniform in Israel during Biblical times. For instance, in the Book of Deuteronomy (25:13-15) the following command is given: "Thou shalt not have in thy bag divers weights, a great and a small. Thou shalt not have in thine house divers measures a great and a small. But thou shalt have a perfect and just weight, a perfect and just measure shalt thou have: that thy days may be lengthened in the land which the Lord thy God giveth thee." And in the Book of Proverbs the Bible counsels "A just weight and balance are the Lord's: all the weights of the bag are his work" (16:11), from which it follows that "Divers weights, and divers measures, both of them are alike abomination to the Lord" (20:10). The many other references to weights and measures in the Old Testament, including the dimensions of Noah's ark and the vital statistics of the giant Goliath, are ample evidence of the everyday concern with weights and measures in ancient times.

While the Greeks and the Romans originated very few innovations in metrology, they did affect the evolutionary process in three important ways. First the Greeks adopted, with very little change in value, the Eastern weights and measures and brought them into use on the European continent [21]. From Greece they passed to Rome, from which they were spread throughout Europe by military conquests and commercial activities [22]. Secondly, the Romans adopted the duodecimal division (base 12) for their primary units, the foot and the pound, which is still in use for certain units of the customary system [23]. The third contribution was to the nomenclature of weights and measures. For example, the fact that the abbreviation for the pound is "lb." may be attributed directly to the Latin word *libra,* meaning "weight." The 12 divisions of the Roman *pes,* or foot, were called *unciae,* from which the Anglo-Saxon words "inch" and "ounce" are both derived [24]. The word "mile" is also of Latin origin, the Romans having established the *mille passus* (one thousand paces) as a convenient unit for measuring longer distances [25].

Before its downfall, Imperial Rome had managed to disseminate its system of weights and measures from England to Asia Minor, and to do it in such a way that some of the units we still use have values not very far removed from those of 2000 years ago. In fact, the difference between the "foot" of Roman times and the "foot" we use today is less than four-tenths of an inch [26].

2. EVOLUTION OF THE CUSTOMARY SYSTEM OF WEIGHTS AND MEASURES

With the decline of the Roman empire, strict control over weights, measures and coinage became impossible and what had once been a nearly universal system in Europe degenerated, like the rest of society, to a mostly local affair. The so-called "customary" family of European and English weights and measures was the result of stresses and strains on the Roman system which occurred during the "middle ages." As summarized in a recent account:

> "Like much else that went into the fabric of medieval civilization, our measuring units are the result of interaction among . . . various Roman, Barbarian, and Islamic influences. Certain units like the foot and the pound survived from Roman usage. Many others were Germanic in origin, while still others like the premetric units in France for measuring the area of farmland (the *arpent*), journey distance (the *league*), and perhaps even the bushel and gallon, were apparently Celtic in origin and therefore predated and survived the period of Roman occupation of what is now France. There were important influences from the Islamic world. The transmission by the Arabs of the ancient Hindu numerals is perhaps the most obvious example. These so-called Arabic numerals were first introduced into the Latin west from Muslim Spain at the end of the 10th century, but their use did not immediately become widespread and for several centuries both the Roman and Arabic systems were simultaneously employed [27]."

The overall result of this blending of cultures was a very complex agglomeration of units and standards of weights and measures.

In England, the measures of length, weight, and capacity used by the Anglo-Saxons, the exact origins of which are unknown, became the dominant system when the Normans made no change following the conquest of 1066 [28]. Thus the earliest recorded standard of length in England was the yard, or *girth,* of the Saxon kings, as modified by Roman influences, which was kept, along with other standards, at Winchester [29]. These standards, which the Normans removed to Westminster Abbey in London, allegedly date back to the reign of King Edgar, who ruled from 958 until 975 [30]. In the Domesday Book of 1086 the Saxon yard was used as a unit of land measure and in 1225 the Magna Charta signed by Henry III provided that there should be throughout the realm one measure of wine, one of ale, and one of corn, and that it should be of weights as of measures [30]. The English statute books as of 1324 prescribed the English system of length as follows: the inch (three barleycorns, round and dry), the foot (12 inches), the yard (3 feet), the perch (5 1/2 yards) and the acre (40 perches long by 4 perches wide) [31].

The unit of weight and of money in England has been the "pound" since Saxon times, although several different pounds—including the Tower pound, the Troy pound, and the avoirdupois pound—have been used. The assize of Bread and Ale of 1266 defined the English Tower system of weight and capacity:

> "An English penny called a sterling, round and without any clipping, shall weigh thirty-two wheatcorns in the midst of the ear; and twenty pence do make an ounce, and twelve ounces a pound: and eight

> pounds do make a gallon of wine, and eight gallons of wine do make a bushel, which is the eighth part of a quarter [32]."

Eventually, this Tower system gave way to the French weights—first the Troy pound (which was 3/4 of an ounce more than the Tower pound) and, later, the avoirdupois pound (our currently-used pound of 16 ounces) [33].

The sheer number of units that got into everyday use in the English system over the years was staggering and, while the names may be considered picturesque today, they must have been the source of great confusion and many frauds. For example, for measuring weight there were, among others, the clove, the stone, the hundredweight, and the sack. For measurements of capacity Englishmen could choose from the pottle, the gallon, the bushel, the firkin, the stake, or the cartload. While not all of these were officially sanctioned, of course, they did exist and had to be dealt with in daily life.

In addition to a proliferation of units, many trades and occupations developed separate measurement systems just for their own use—surveyors used poles and chains, apothecaries employed minims and drams, and mariners were accustomed to fathoms, knots and cable lengths. In still other cases units having the same name carried different values, such as the "long" ton and the "short" ton. Finally, the values of many units of weights and measures were entirely dependent upon the commodity to be bought or sold. Thus a gallon of wine was different from a gallon of ale, and a bushel of corn was generally leveled off before selling it while a bushel of wheat was often bartered rounded or "heaped." Many times, however, this depended on whether the commodity was being bought or being sold. At any rate, although the need for uniformity was often recognized in the laws of Great Britain from the 11th century onward, the successes of various monarchs and Parliaments were, at best, limited.

Nor was the situation any different in other European countries. In describing the situation in pre-metric France metrologist Henri Moreau wrote:

> "One dominant fact should be noted: the uniformity [that was legislated] was illusory. The units varied, not only from country to country, and . . . from province to province, but even from city to city, and also according to corporation or guild. Of course, this state of affairs led to errors, frauds, and continual misunderstandings and disputes . . . The multiplicity of names given to poorly determined units and the diversity in the multiples and submultiples of the principal measures increased the confusion [34]."

The contrast in the ways in which the British and French went about solving this confusion in weights and measures is noteworthy. France simply discarded her old system and substituted a new one in its place. England, on the other hand, gradually improved its weights and measures situation through enforcement of stricter laws, made changes in furtherance of her great industrial prowess, and managed to achieve a widespread geographical distribution of its system through colonization and settlement. While the

French system grew because of its appealing simplicity and logic, the English system was the basis for the vast majority of commercial dealings and, even more important, was the one used to construct British machinery, which was much in demand.

Until the middle of the 20th century, then, most of the English speaking nations of the world retained the customary system of weights and measures. Even in non-English speaking nations some customary units were widely used in fields for which British and American industrialists or engineers had "written the book." Of particular consequence to the debate on the metric system in the U.S. are the fields of textile manufacturing, tool manufacturing, and the production of heavy machinery. But these developments were not to occur until more than 100 years after the birth of the metric system.

3. THE CREATION AND GROWTH OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES

The metric system presents an entirely different case from that of the customary system. As already noted, it did not evolve from ancient measures and practices to assume its ultimate configuration—it was created whole and put into use under unusual conditions and to serve very specific purposes. Furthermore, it is based on what were, at the time of its creation, the most advanced scientific principles known. It has been called by one writer "the first example of scientific rationalization by society [35]." Because of its comparatively recent origins (1790), its inception and subsequent growth are well documented.

The need for a reform of French weights and measures has already been noted. When the opportunity arose to institute such a reform, the French Government acted quickly and decisively in determining what should be the nature and extent of the change.

Although the intellectual foundation for the metric system had been laid by the rebirth of scientific interest in France between the 16th and 18th centuries, it was the cataclysm of the French Revolution which propelled it into a practical reality. As very little was spared during this time in the attempt to purge France of all vestiges of the feudal system and of kings who ruled by divine right, it should not be surprising to find that the royal system of weights and measures was on the agenda of changes to be made. While not all of the reforms instituted during the Revolution have been permanent—the revolutionary calendar and mathematical innovations such as dividing the circle into 100 parts led short lives—the change in weights and measures proved to be a lasting one. It is a tribute to the Revolutionary government that they did not act capriciously in making the change but, rather, turned to science to get the job done. Nor were French scientists the only ones involved (although the most credit belongs to them) for, with the object in mind of devising a truly international system, foreign scientists were invited to participate in the process from the very beginning.

In searching for a "founding father" of the metric system historians have settled on Gabriel Mouton (1618-1694), the vicar of St. Paul's Church in Lyons, who proposed a comprehensive decimal system of weights and measures in the year 1670 [36]. Taking a basic unit from the physical universe instead of from the human body, Mouton adopted the length of an arc of one minute of a great circle of the earth (i.e., a full line of longitude or latitude) as his principal unit of length, which he called the *milliare* [37]. This he divided by successive powers of 10 to get subunits, selecting one of these to correspond approximately to the customary French foot. This he further defined as equal to the length of a pendulum that would beat 3,959.2 times in a half hour at Lyons [38]. The proposal for use of a pendulum was repeated by others—Picard in 1671 and Huygens in 1673—but was never acted upon by the prerevolutionary French Government [39].

The political sponsor of weights and measures reform in the Revolutionary National Assembly was the Bishop of Autun, better known as Charles-Maurice de Talleyrand. In April of 1790 he put before the Assembly a plan for reform based on a pendulum beating seconds at 45° latitude [40]. New and extremely precise measurements were to be undertaken to determine the length of the pendulum. To effect this investigation a decree was issued by the Assembly on May 8, 1790 and approved by Louis XVI on August 22, 1790. In addition to calling for the investigation, the law decreed that:

> "The King shall also beg His Majesty of Britain to request the English Parliament to concur with the National Assembly in the determination of a natural unit of measures and weights; and . . . under the auspices of the two nations the Commissioners of the Academy of Sciences of Paris shall unite with an equal number chosen by the Royal Society of London . . . to deduce an invariable standard for all the measures and all the weights [41]."

Accordingly, the French Academy appointed several committees to carry out this work without waiting for Britain to accept the invitation (an event never to occur). One of these committees reported quickly, on October 27, 1790, urging the adoption of a decimal basis for the new system [42]. Recommendations on the primary task, defining a new unit of length measurement, were contained in a report of March 19, 1791. After consideration of several alternative possibilities, the committee recommended the adoption of a unit equal to one ten-millionth of the length of a quadrant of the earth's meridian (i.e., one ten-millionth of an arc representing the distance between the Equator and the North Pole) [43]. This unit was later[2] given the name *Metre*—a derivative of the Greek word *metron,* meaning simply "a measure." The unit of mass was to be derived by cubing some part of this length unit and filling it with water. The same technique would also provide the capacity measure [44]. In this way, the standards of length, mass and capacity were all to be derived from a single measurement, infinitely reproducible because of natural origins, precisely interrelated, and decimally-based for convenience.

The committee report also recommended, and the Academy approved, the way in which the standard was to be determined, namely by measuring an arc of meridian between Dunkirk, in France, and Barcelona, in Spain. While

[2] In May 1793.

there were several important technical, practical, and political reasons for this recommendation, the fact that the terrain involved had already been surveyed [45] was an important one because it made possible the construction of a provisional standard without waiting for completion of the full survey. In 1793 when an upheaval of the Revolution led to the abolition of the Academy and its committees on weights and measures and frequently caused the surveying team to be harrassed (even arrested on several occasions) [46], the existence of the provisional meter may well have kept alive the metric system reform. The fact that the new units were officially adopted on the basis of the provisional standard by a decree of 1795 also enhances the value of its existence. Under the terms of this same law Greek prefixes were given to the multiples of each of the units (deca = x 10; hecto = x 100 and so on) and Latin prefixes were assigned to the subdivisions (deci = 1/10; centi = 1/100; and so forth). This feature has been retained to the present day.

Despite the adversity it had experienced, the surveying team (under the direction of two gentlemen named Mechain and Delambre) completed its work in November of 1798 [47]. Construction of the final standards, a platinum meter and kilogram, was completed the following June [48].

Concurrently, in the autumn of 1798, steps were again taken to insure that the metric system would be a truly international one. Talleyrand, by then Minister of Foreign Affairs, invited all European countries as well as other friendly and neutral states to send representatives to Paris to learn of the work that had been done and to participate in the formal adoption of new standards [49]. In all, nine nations accepted invitations, including modern-day Italy, Denmark, the Netherlands, Spain and Switzerland [50]. While there were no immediate results from this convocation of leading scientists in terms of other nations deciding to adopt the new system, the idea was a resounding success considering the political climate in which it was held. A fairly broad spectrum of participation had been secured, a definite educational process had been served, and a precedent of multinational collaboration had been set which was to have significant impact in future years.

It cannot be claimed, however, that the new system met with instantaneous approval. Even in France the transition was not effected quickly or smoothly, for although the system was made mandatory throughout France in 1795, its use was not enforced. Secondary standards had not even been constructed for distribution to the Departments (i.e., the French equivalent of states), to say nothing of commercial and household weights and measures [51].

The plight of the metric system was further aggravated in 1812, when Napoleon Bonaparte issued a decree allowing the old units to return. Under his *usuelle* system of measurement all measures were defined in terms of metric standards, but the old unit names were specified and the decimal ratios between units and their parts were discarded [52].

For a time, Napoleon's act was popular, probably because the metric system had not been in use long enough to fully supplant the older and more familiar system. This confused state of affairs was not allowed to exist for long, however, and, on July 4, 1837, the following act was passed:

"After January 1, 1840, all weights and measures other than the weights and measures established by the laws of 1795 and 1800, constituting the decimal metric system, shall be forbidden . . . Those possessing weights and measures, other than the weights and measures above recognized, in their warehouses, shops, workshops, places of business, or in their markets, fairs, or emporiums, shall be punished in the same manner as those who use them . . . Beginning at the same date all denominations of weights and measures other than those authorized are forbidden in public acts, documents, and announcements. They are likewise forbidden in acts under private seals, commercial accounts, and other private legal documents, etc. [53]."

Following this action, the metric system began to experience a gradual but steady growth which saw it taken up by one country after another. Some of the Italian provinces, Greece and the Netherlands had already accepted it by 1840. In 1849 Spain joined their ranks. The international exhibitions of 1851, 1855, and 1862 did much to promote the commercial advantages of the metric system, and, at the time of the 1867 exhibition, an international committee on coinage, weights and measures—the first of many—met in Paris [54].

In fact, the growth in use of the metric system after 1850 is little less than phenomenal. By 1880 17 nations—including most of South America and the major European nations of Germany, Austria-Hungary, Italy, and Norway—had officially accepted the metric system at least for government purposes, and 18 more nations were added to this list by 1900 [55]. The reasons for this growth are accounted for by historian Edward F. Cox:

"As a result, then, of a quarter-century of developments conducive to its diffusion, this child of science, born of the dread French Revolution, had been transformed . . . into the formally acknowledged international system . . . [A] solid foundation had been laid for its further, later dissemination . . . The fundamental reasons for such a phenomenon are found in the milieu of the latter half of the nineteenth century. As indicated, it was part and parcel of the growing internationalism. The metric system was the scientifically recommended one in an age when science and its products were being welcomed into society. The many national adoptions produced a 'band-wagon' effect and induced further adoptions. The great acceleration of world trade led men of commerce, with ever greater familiarity, to proclaim the virtues of the system and to urge more adoptions. It was often associated with 'Progress' in an age of 'Progress' [56]."

Among the leading industrial nations of the world at the dawn of the 20th century, only Britain and the United States had not accepted the metric system (although others that were to become great—Russia, Japan and others in the British Commonwealth—had not accepted it either at that time). At least in the case of the United States and Britain it was not because these overseas developments had escaped attention. In fact, the exact opposite was true. From its very beginnings as an independent nation the United States has been concerned with its system of weights and measures and has often considered the notion of changing it, although this has been neither an easy nor a decisive process.

II. TOWARD A MORE PERFECT UNIFORMITY (1607-1860)

The time from the settlement of Jamestown until the outbreak of the Civil War is important in the history of U.S. weights and measures. It has often been claimed that the adoption of an entirely new system of weights and measures would have been a simple matter in the days when the U.S. was a geographically small and agrarian nation with a mostly homogeneous population. But such matters are relative. It is clear from the writings and actions of this period that those who would have been involved in the change were not quite so sanguine about the ease with which it might be made. Although the metric system began its life in the same year that the U.S. Constitution was ratified, 1790, it was not until 1821 that it was even considered as a reasonable option. Unlike the conditions in France at the time of their Revolution, when everything even remotely associated with the old regime was cast aside, the U.S. not only retained, but even deliberately cultivated, its English heritage. It is true that the courses of action taken during this period had the effect, in later years, of complicating the question of adopting the metric system. This has been compensated for by the fact that the one action which might have permanently precluded the metric system from future consideration in the U.S. — the formal adoption by legislation of the English customary system — was not taken. In the final analysis, then, the most regrettable aspect of the period was the indeterminate nature of what was done and this has had the beneficial effect (at least for the metric system) of leaving the door open to adoption at a later date.

Most of the activity during this period occurred during the formative years of the U.S. as an independent nation: 1782 to 1838. Among the many lasting accomplishments of this era, marked by the confluence of philosophical idealism and the harsher realities of political and economic independence, were the adoption by the U.S. of an innovative system of coinage and the ratification of a Constitution giving to Congress the power "to fix the standard of weights and measures." Several legislative committees held inquiries which eventually resulted in the enactment of a number of important laws and resolutions. The executive branch, in carrying out the wishes of Congress, also contributed to establishing a uniformity of weights and measures within the U.S. Two American Secretaries of State, both of whom were later to achieve the Presidency, conducted penetrating investigations on the subject of weights and measures and submitted reports of unparalleled excellence to Congress. In brief, the failure to act decisively was not due to inattentiveness, but rather to a reluctance to act too hastily in either casting aside the old and familiar or accepting the new and untested.

A. WEIGHTS AND MEASURES IN THE UNITED STATES PRIOR TO RATIFICATION OF THE CONSTITUTION

Concerning the earliest weights and measures in the U.S., it is sufficient to note simply that the people who settled the North American continent brought with them the commercial implements and practices of their homelands. For this reason there was no uniformity of weights and measures in the colonies at first. With political and social amalgamation, however, came legislation dealing with this situation.

The earliest recorded statute on weights and measures in the U.S. is an order of the general assembly of the colony of Virginia dated March 5, 1623—only 16 years after the founding of Jamestown. The order provided that no weights and measures were to be used which had not been sealed by a duly-appointed officer of the Colony [1]. This was followed in 1631 by an ordinance fixing the barrel of corn in accordance with the English Winchester bushel. Similarly, a 1641 Massachusetts statute prescribed that all casks used in the sale of liquor, beef, fish, pork or other commodities should be of London assize. Both Virginia and Massachusetts enacted several other ordinances on weights and measures during the 17th century, all relating local weights and measures to the standards of the Exchequer in London.

As the colonies gained in stature and in population, more weights and measures laws were added to the statute books. By 1700 Pennsylvania had taken steps to protect the integrity of its commercial dealings and New York, following its change from Dutch to English hands, had done likewise by 1703. Others followed in rapid succession: Delaware, in 1705; Maryland, in 1715; and New Jersey, in 1725. These laws notwithstanding, there was still a wide diversity of weights and measures from one colony to the next. Even so, commercial relations flourished.

With the achievement of independence and the creation of a new Union, provision was made for establishing uniform standards. By article 9, paragraph 4 of the Articles of Confederation (1777), Congress was given the "sole and exclusive right and power of regulating the alloy and value of coin struck by their own authority, or by that of the respective states; fixing the standard of weights and measures throughout the United States." Although a proposal was laid before the Continental Congress to have the board of treasury report an appropriate ordinance on weights and measures, no action was taken [2]. The Continental Congress did act with alacrity in dispatching its duties with respect to coinage, however.

B. THE ADOPTION OF A DECIMAL SYSTEM FOR U.S. COINS

Throughout history, systems of coinage have almost always been the direct descendants of a nation's weights. This was true in ancient Mesopotamia, Greece, Rome, and, especially, in Great Britain. The conduct of the U.S. in establishing a new and radically different system of coinage in the 1780's without providing for the establishment of weights in the process of doing so may therefore be viewed as an anomaly. Nevertheless it was done and the action merits a brief review at this point because the primary power behind the innovation of decimal coinage, Thomas Jefferson, was later to attempt to apply the same principle to U.S. weights and measures.

A grave situation existed in the United States with respect to coinage during and immediately after the Revolution [3]. Monies were clipped and sweated to obtain the precious metals; a constant outflow of specie resulted from our deficient balance of trade; and so many foreign coins with so many different values were in circulation that commerce was hindered. When made aware of the situation, Congress, on January 7, 1782, ordered Superintendent of Finance Robert Morris to investigate it and render a report [4].

Eight days later the report, prepared by Assistant Financier Gouverneur Morris, was submitted to Congress along with a plan to establish a standard of value and adopt a new monetary unit. The recommendations that he offered included a proposed system bearing a close affinity with the former currency; a plan to establish a mint and adopt a standard for coinage weights; a fundamental monetary unit based on the Spanish piece of eight (which was widely used at the time), and for which he suggested that its formal name—"dollar"—be used; and, finally, the adoption of a decimal ratio for the coins to be minted [5]. His reasons for proposing a decimal ratio were stated as follows:

> "Although it is not absolutely necessary, yet it is very desirable, that money should be increased in decimal ratio, because by that means all calculations of interest, exchange, insurance, and the like, are rendered much more simple and accurate, and of course, more within the power of the great mass of the people [6]."

Eventually this report was turned over to a committee for review, one of the members of which was Thomas Jefferson. While Jefferson was intrigued with the proposals, he felt certain modifications were needed to make the system manageable "for the common purposes of society [7]." He therefore proposed that the dollar be made the unit of account, with its multiples and subdivisions being derived decimally. In a later paper he outlined what he considered to be the three requisites of a money unit [8]. First, it should be of a convenient size for daily transactions. The dollar, he felt, met this criterion: "I question if a common measure of more *convenient size* than the Dollar could be proposed. The value of 100, 1,000, 10,000 dollars is well estimated by the mind; so is that of a tenth or hundredth of a dollar. Few transactions are above or below these limits [9]." Jefferson's second *desideratum* was that the parts and mutliples be in an easily calculated proportion to each other. For this purpose the decimal ratio was clearly favored. Finally, the unit should be sufficiently close to the value of some known coins so as to be easily adopted by the people. In this respect also, the dollar was not found wanting: "It is difficult to familiarize a new coin to the people; it is more difficult to familiarize them to a new coin with an old name. Happily, the dollar is familiar to them all, and is already as much referred to for a measure of value, as their respective provincial pounds [10]."

When the combined reports of Jefferson and Morris were considered in Congress, on July 6, 1785, the dollar was adopted as the unit of U.S. coinage by a unanimous vote [11]. More than a year later, on August 8, 1786, a complete decimal system of coinage was approved by Congress [12]. Under the terms of this Act, the standard was set at 11 *parts* fine gold or silver and one *part* alloy, with the unit being 375.64 Troy grains of silver. In this way, the question of weight units was avoided for the time being.

The final step in implementing the new coinage system was the establishment of a mint to do the actual coining. After more than 5 years of study and discussion this was accomplished by passage of the Mint Act on April 2, 1792 [13].

The execution of the new system was not rapid, however, nor was it an overnight success. As noted by Adams in 1821:

> "It is now nearly thirty years since our new moneys of accounts, our coins, and our mint have been established. The dollar, under its new stamp, has preserved its name and circulation. The cent has become tolerably familiarized to the tongue . . . But the dime having been seldom, and the mille never, presented in their material images to the people, have remained . . . utterly unknown . . . Even now, at the end of thirty years, ask a tradesman, or shopkeeper in any of our cities what is a dime or a mille, and the chances are four in five that he will not understand your question. . . . [They] remain, to the great mass of the people, among the hidden mysteries of political economy—state secrets [14]."

While the subject of U.S. coinage *per se* is beyond the scope of this account, the Acts which established a decimal system of coinage impinge heavily on the history of the metric system. These decisions were oftentimes singled out in later years as precedents. Advocates of metric adoption were quick to use our coinage system as a demonstration of the advantages of a decimally-based system and the actions which established it were offered as proof of the ease with which such changes could be made. While the advantages of decimal ratios for computation and the desirability of a consistency between systems of enumeration, coinage, and measurement cannot be denied, the analogy between our coinage system and the metric system of weights and measures breaks down on several counts. Chief among these is the fact that governments are able to establish absolute control over the coins produced and used within their jurisdiction. Governments in short, have a monopoly when it comes to monetary systems. As yet, no government has been able to do the same for its measurements, nor has this often been an avowed purpose of government. This and other discrepancies between systems of coinage and measurement will be elaborated on in subsequent chapters. The important point is that the similarities were used as a part of the pro-metric case on several occasions and thus became a factor in the debate over metric adoption.

C. CONSTITUTIONAL PROVISION FOR WEIGHTS AND MEASURES AND THOMAS JEFFERSON'S PROPOSALS

The year 1790 saw an unusual occurrence in the history of weights and measures; France, Great Britain and the United States were all seriously contemplating major changes in their systems of weights and measures in order to reduce diversity and confusion. Unfortunately this common interest was not strong enough to overcome political barriers even for the sake of international uniformity in weights and measures, and an extraordinary opportunity was foregone. It should be remembered that it was indeed a real opportunity because France, in approving Talleyrand's proposal, had invited British participation in fixing a new standard. Had Great Britain been a party to these proceedings, which led to the inception of the metric system, the United States might very well have accepted the new system at an early stage in its development.

But Britain had other ideas. Sir John Riggs Miller, addressing Parliament on February 5, 1790, deplored the existing situation with respect to weights and measures in that country and offered two resolutions, which were unanimously agreed to [15]. These resolutions required, in effect, a survey of the weights and measures used in all the cities and towns of England and Wales. On April 13, 1790, Sir John again spoke in Parliament, this time to urge adoption of a measurement standard taken from something permanent and uniform in nature and to state the desirability of a decimal ratio for weights and measures and of uniformity with the systems of other nations [16]. Neither the survey nor Sir John's appeals inspired a reformation of the English system of weights and measures in 1790.

In the U.S. the Constitution ratified by the States reaffirmed the Articles of Confederation by giving Congress the power "to fix the Standard of Weights and Measures" (art. 1, sec. 8). Even before that, on January 8, 1790, President Washington had addressed attention to the subject in his first message to Congress by saying "Uniformity in the currency, weights, and measures of the United States, is an object of great importance, and will, I am persuaded, be duly attended to [17]." The matter was referred to the

Secretary of State, Thomas Jefferson, who was requested to prepare a suitable plan for consideration by the House of Representatives.

Jefferson submitted two plans to the House on July 4, 1790, one based on the assumption that a new system of weights and measures was desired by Congress, the other a plan to simply "define and render uniform and stable" the weights and measures already in use.

Before outlining his plans, however, Jefferson noted the need for an invariable standard of length. Although, ideally, this would be some measure occurring in nature, Jefferson said, he did not believe an appropriate measure of this type could be found. Instead, he proposed basing the standard on the motion of the earth on its axis, which "though not absolutely uniform and invariable, may be considered as such for every human purpose [18]." Like Mouton and others following him, including Talleyrand, Jefferson settled on the *principle* of the length of a pendulum beating seconds of mean time. However, Jefferson observed that, as a scientific device, the pendulum had several drawbacks, including its susceptibility to temperature changes and the difficulty of locating precisely its center of oscillation. In its stead, he proposed:

> "A uniform cylindrical rod of iron, of such length, as, in the latitude 45° in the level of the ocean, and in a cellar, or other place, the temperature of which does not vary through the year, shall perform its vibrations, in small and equal arcs, in one second of mean time [19]."

This rod, the idea of Philadelphia watchmaker Robert Leslie, would obviate all of the sources of uncertainty in the pendulum principle, Jefferson believed. This theory and the rest of the scientific matter in the report had been carefully reviewed and confirmed by David Rittenhouse before the document was submitted to Congress [20].

Jefferson's plan for improving the weights and measures already in use was to adjust them to the new standard of length as proposed above. Using reports published in 1758 and 1759 by committees of the House of Commons as his basic source of information on English weights and measures, he laid out a system for all measures of length, area, capacity and weight. Because the most serious problems in attaining uniformity were with measures of capacity, Jefferson settled on a standard gallon; discarded the distinction between wet and dry measures; proposed rectangular rather than cylindrical standards for ease of measurement; and defined the rest of the series in terms of this 270 cubic inch standard using English terms and ratios [21]. For weights, Jefferson proposed as a standard:

> "An ounce is of the weight of a cube of rain-water, of one-tenth of a foot, or rather, that it is the thousandth part of the weight of a cubic foot of rain-water, weighed in the standard temperature: that the series of weights of the United States shall consist of pounds, ounces, pennyweights, and grains; whereof
>
> 24 Grains shall be one penny-weight;
> 18 Penny-weight one ounce;
> 16 Ounces one pound [22]."

The balance of Jefferson's report was devoted to the second, and more widely known, plan for a decimal system of weights and measures. One thing that Jefferson made clear was the fact that he considered this plan to be a logical extension of the decimal coinage concept with which he had been involved so recently.

"The experiment made by Congress in 1786 . . . has obtained such general approbation, both at home and abroad, that nothing seems wanting, but the actual coinage, to banish the discordant pounds, shillings, pence, and farthings of the different states . . . Is it in contemplation with the House of Representatives to extend a like improvement to our Measures and Weights, and to arrange them also in a decimal ratio [23]?"

"But if it be thought that, either now, or at any future time, the citizens of the United States may be induced to undertake a thorough reformation of their whole system of Measures, Weights and Coins, reducing every branch to the same decimal ratio already established in their coins, and thus bringing the calculation of the principal affairs of life within the arithmetic of every man who can multiply and divide plain numbers, greater changes will be necessary [24]."

For linear measurement, according to Jefferson's system, the rod beating seconds would yield the reference standard, which would then be divided into five equal parts, each to be one foot. This would be the basis for the following [25]:

Multiples	*Subdivisions*
10 feet = 1 decad	1/10 foot = 1 inch
10 decads = 1 rood	1/10 inch = 1 line
10 roods = 1 furlong	1/10 line = 1 point
10 furlongs = 1 mile	

Superficial measures, or measures of area, would be based on these, with the square rood (100 feet to a side) replacing the "acre." Similar innovations were proposed for measures of capacity, with the basic unit being a one cubic foot bushel. Weight would still be derived from a cubic inch of rainwater, and the basic unit would be the ounce. Provisions were also made for very small and very large weight units, as in the progression below [26]:

Multiples	*Subdivisions*
10 ounces = 1 pound	1/10 ounce = 1 double-scruple
10 pounds = 1 stone	1/10 double-scruple = 1 carat
10 stones = 1 kental	1/10 carat = 1 minim
10 kentals = 1 hogshead	1/10 minim = 1 mite

These units would also be adopted as the basis for the coinage system by simply enlarging the amount of silver contained in the money unit by about one-third of a grain. This would have the effect of linking the monetary system and the system of weights and measures to each other in direct proportion.

Jefferson concluded his report by noting that the decimal plan would provide for determinate, unchangeable standards which would be accessible to all citizens, would keep the weights and measures of a size close enough to those already in use to minimize problems of introducing a new system, and would permit calculations to be made easily. He also stated that he favored a gradual change to the new system, but not too long a postponement as that would increase the difficulties [27].

Before discussing the disposition of Jefferson's plans in Congress, it should also be noted that Jefferson was aware of Talleyrand's proposal to the French National Assembly. Although his report was somewhat delayed while he evaluated the French decree, he was apparently not influenced by it very much. Jefferson did note, in his letter of transmittal to the Speaker of the House, that he had originally planned to use 38° latitude as the geographical point for fixing the standard.[1] After receipt of the French plans, however, he changed his recommendations to 45° latitude in the interests of possible future negotiations to achieve uniformity with France and Great Britain. This change, of course, necessitated a revision of many of Jefferson's calculations.

Jefferson was not enamored of the metric system as it was eventually formulated, primarily because the meridian had been substituted for the pendulum as the standard. This, he felt, detracted from the possibilities of international uniformity:

> "The element of measure adopted by the National Assembly excludes, *ipso facto,* every nation on earth from a communion of measure with them; . . . Instead of concurring . . . in a measure which, like the pendulum, may be found in every point of the 45th degree, and through both hemispheres, and consequently in all countries of the earth lying under that parallel, either northern or southern, they adopt one which can be found but in a single point of the northern parallel, and consequently only in one country, and that country is theirs." (from a letter to William Short of New York dated July 28, 1791) [28].

What disturbed Jefferson about the metric system, then, was the fact that the basic measurement could not be reproduced in any country except France, so that other nations would either have to trust the French results or take the trouble of sending people to France to verify it for themselves. He did admire the courage with which the reform was carried out, however [29].

D. CONGRESSIONAL CONSIDERATION OF JEFFERSON'S PROPOSALS; EVENTS LEADING UP TO JOHN QUINCY ADAMS' INVESTIGATION

It was not until 1796 that discussion of weights and measures in Congress based on Thomas Jefferson's report came to an end. Although no laws were

[1] The median latitude of the United States in those days. If the measurements were made at sea level, a location between Richmond, Va. and Washington, D.C. would likely have been selected for determining the standard.

passed as a result of his work, the extent of consideration given to the report attests to the importance of the subject.

Jefferson's report was presented to the House on July 13, 1790, and was promptly "tabled [30]." On December 8, 1790, President Washington delivered his second message to Congress and again urged action on the matter of standards of weights and measures. On December 28 the report was sent to the Senate, where it was referred to a special committee.

On March 1, 1791, Senator Izard made the following report on behalf of the committee:

"As a proposition has been made to the National Assembly of France for obtaining a standard of measure which shall be invariable, and communicable to all nations, and at all times; as a similar proposition has been submitted to the British Parliament, in their last session; as the avowed object of these is, to introduce a uniformity in the measures and weights of the commercial nations; as a coincidence of regulation, by the Government of the United States, on so interesting a subject, would be desirable, your committee are of the opinion, that it would not be eligible, at present, to introduce any alteration in the measures and weights which are now used in the United States [31]."

When no action to fix the standards was taken on the strength of this recommendation, President Washington broached the subject for the third time, on October 25, 1791, stating: "A uniformity in the weights and measures of the country is among the important objects submitted to you by the Constitution and, if it can be derived from a standard at once invariable and universal, must be no less honorable to the public councils, than conducive to the public convenience [32]."

On November 1, the Senate formed another committee to reconsider the matter. This report, again prepared by Senator Izard, was submitted on April 4, 1792. This time the committee recommended the establishment of Jefferson's proposed standard and the adoption of a decimal system of weights and measures derived from it that substantially followed his plan. Consideration of these suggestions was postponed until the next session of Congress. In the following session, consideration was again deferred several times. When the subject was opened for discussion, on December 17 and 18, 1792, motions were substituted for the committee's recommendations that would, if enacted, have required retention of the weights and measures then in use, but based on the new standard as proposed by Jefferson. No action was taken on any of these motions.

Three years elapsed before the subject was raised again. This time on January 8, 1795, President Washington communicated to the Congress a letter from the Minister of the French Republic, M. Fauchet, outlining the actions recently taken by France and recommending, with some urgency, the adoption of the metric system by the United States. At the same time, a copper meter and a copy of the kilogram, both replicas of the French provisional standards, were sent to the Secretary of State by M. Fauchet [33]. These standards had been sent to the U.S. by France under the terms of a decree of December 11, 1793, in the hopes of securing true international uniformity [34]. Given our Revolutionary-period alliances with France, the U.S. might have been receptive to the proposal a few years earlier. In 1795, however, relationships between the two countries were badly strained by America's refusal to take sides in the dispute between the British and the French. The standards were never used. Nor was the U.S. invited to send representatives to the international gathering at Paris in 1798-99 that formalized the metric system for this same reason. In the end, whatever the U.S. propensities toward the desirability of adopting the system because of its scientific excellence may have been, the prevailing political conditions almost certainly spelled the doom of the metric system in the early days of U.S. independence.

Whatever the reason, further action was put off for nearly a year. In December of 1795 the House of Representatives appointed a select committee to consider both Jefferson's report and the French communication. Recommendations were made by the committee on April 12, 1796, and on May 14 the House formed itself into a Committee of the Whole to consider them. Among other things, the committee suggested "That the unit of measures in length [from which measures of area, capacity and weight were to be obtained], and the units of weights to be adopted as standards ought not to vary in any sensible degree from the present foot now in use and the present pound avoirdupois [35]." Eventually the House, as a Committee of the Whole, decided to authorize the President to have experiments conducted to determine the length of a pendulum rod, the weight of a cube of rain water, and the respective weights of the divisions of the pound. The sum of $1,000 was to be appropriated to cover expenses, and a bill to this effect was ordered to be drawn up. Five days later this bill—"directing certain experiments to be made to ascertain uniform standards of weights and measures for the United States" [36]—was passed by the House with little opposition. The bill was sent to the Senate but consideration of it was deferred. The bill was never resurrected.

For all practical purposes this marked the close of Congressional consideration of Thomas Jefferson's plans. For several years thereafter resolutions passed by the States urging the adoption of uniform standards were sent to Congress, but little action resulted. Most of these resolutions were made in the form of memorials; Rhode Island (1798), Delaware (1806), New Jersey (1808), and Maryland (1810) were among the States exhibiting concern. During this time, however, Congress did enact its first statute on weights and measures. In 1799 the Surveyor Act was passed, ordering the surveyor of each port to examine and test the weights, measures and instruments used in collecting customs duties at least twice each year. As no standard had been adopted, however, the statute could not be put into effect.

Two other actions worthy of note were taken by the executive branch prior to 1821. In 1805 a "committee meter," one of 15 iron bars whose lengths had been ascertained in the process of constructing the original meter, was brought to the United States by Ferdinand Rudolph Hassler [37]. This bar had been given to Hassler by Mr. J. G. Tralle, a representative from what is now Switzerland to the 1798 convocation in Paris formalizing the metric system. In 1807 when the Survey of the Coast (later the U.S. Coast and Geodetic Survey) was organized with Mr. Hassler at the head of it, this meter was made the standard of length for that work. Until 1890 all the base measurements of the Survey were referred to this meter.

In 1814 an 82-inch bronze bar with an inlaid silver scale was procured from an instrument maker, Troughton of London, also for use in the Coast Survey [38]. This bar was merely a copy of Troughton's scale and had not been compared with the standard British yard. Nevertheless, the distance between the 27th and 63d inches, representing 36 average inches of the bar, was taken to be equal to the London yard at 62° Fahrenheit. From 1832 until 1856, this bar served as the unofficial standard of length for the United States by virtue of an administrative action on the part of the Secretary of the Treasury which will be discussed in a subsequent part of this chapter.

On December 3, 1816, President James Madison, in a message to Congress, once more urged action on the problem of a lack of uniformity in U.S. weights and measures by saying:

"Congress will call to mind that no adequate provision has yet been made for the uniformity of weights and measures . . . contemplated by the Constitution. The great utility of a standard fixed in its nature, and founded on the easy rule of decimal proportions, is sufficiently obvious. It led the government at an early stage to preparatory steps for introducing it; and a completion of the work will be a just title to the public gratitude [39]."

Weights and measures had long been of concern to Madison. On April 28, 1785, he had addressed a letter to James Monroe deploring the condition of those in use:

"I hear frequent complaints of the disorders of our coin, and the want of uniformity in the denominations of the States. Do not Congress think of a remedy for these evils? The regulation of weights and measures seem also to call for their attention. Every day will add to the difficulty of executing these works. . . . Next to the inconvenience of speaking different languages, is that of using different and arbitrary weights and measures [40]."

Congress, however, was not disposed to act on the basis of Jefferson's 26-year-old plans. Instead, after due deliberation, the Senate passed a resolution on March 3, 1817, requesting the Secretary of State to prepare a new statement "relative to the regulations and standards for weights and measures in the several states . . . together with such proposition . . . as may be proper to be adopted in the United States [41]."

Concurrently, the House of Representatives continued to consider the question. Several select committees were appointed in 1818-19 to make appropriate recommendations. On January 25, 1819, Representative Towndes reported for a select committee, suggesting the adoption of "absolute standards conforming to the weights and measures in common use [42]." The report went on to list what the units were to be and to note that neither the English system nor the French metric system had managed to become so well established as to secure uniformity. No action was taken on this report during that session of Congress, and when the matter was revived during the next session, Congressman Towndes thought it advisable to wait for the Secretary of State's report to the Senate before acting.

E. THE EXHAUSTIVE INVESTIGATION OF JOHN QUINCY ADAMS

Frequent references have already been made to John Quincy Adams' 1821 *Report Upon Weights and Measures*. If any American work on the subject may be termed a "classic" it is this report. It is by far the most widely cited work in later investigations, being used not only by historians but also by Congressmen and interest group representatives—including those on both sides of the issue of metric adoption. Because Mr. Adams did such a thorough job in laying out the concepts and practices of weights and measures and the advantages and disadvantages to the U.S. in 1821 of *both* the English and metric systems, it is possible to find arguments to support almost any position in this report. His assumptions are clearly stated, as are his facts. His conclusions are deduced from them by logic and backed up by pragmatic reasoning. Adams' recommendations cover both the short- and the long-term, and the entire report is presented in the most eloquent language. And yet his work often has been misinterpreted or misrepresented. Subsequent students of metrology have, of course, been able to find technical flaws—incorrect assumptions, changed situations due to the advances in science since 1821, and the like. But the report also has frequently been used to leave the impression that John Quincy Adams was either unquestionably in favor of the metric system or dead set against it. Neither of these is correct. As this document will play a recurring role in the story of proposed metric legislation in the U.S. (although it was not the *most* important factor in later decisions) it deserves more than just passing notice.

Above all else John Quincy Adams' report reflected the mood of America *circa* 1821. A miniature profile of the concerns of our fledgling Nation can be seen in his references to our English heritage, our dependence upon maritime activities for survival, the beginnings of industrialism,[2] our uncertain position in world affairs and our preoccupation with such domestic matters as States' rights, slavery, westward expansion, and population growth.

A look at the United States in 1821 makes clear why this is so. Between 1801 and 1824 the U.S. doubled in size, with the purchase of the Louisiana Territory from France in 1803 being the major cause. Initial American attempts to remain neutral in the quarrels between Britain and France had come to naught, and the U.S. had fought her second war with the mother country in 1812, ostensibly to protect maritime interests. In 1819 John Quincy Adams negotiated a treaty with Spain which brought Florida into

[2] Adams demonstrated his fascination with man's ability to harness steam in several passages of his report and was clearly impressed with the potential of this power source to the future development of the U.S.

U.S. hands. Ohio, Louisiana, Indiana, Mississippi, Illinois, and Alabama were admitted to the Union before 1820. By 1821 Maine and Missouri had also been admitted, but not before a sectional conflict over the issue of slavery had been dealt with and a compromise agreed upon. Fishing, farming, and shipping were the mainstays of the American economy in 1821, although factories were rapidly beginning to dot the landscape. In order to manage all of these responsibilities, the nation worked hard to avoid potential foreign conflicts. This job was made somewhat easier by the fact that Europe was temporarily enjoying a state of peace following Napoleon's downfall at Waterloo and the formation of the Holy Alliance in 1815. It was against this background that John Quincy Adams prepared his recommendations on weights and measures, and there are very few of the above events which cannot be counted as a factor in his decisions.

As required by the Senate resolution, Adams concentrated his attention on three principal subjects: international developments, the existing situation with respect to weights and measures regulations and standards in the States, and the means available for securing uniformity among them. A subject outline of his report shows how it was approached:

I. Interpretation of the Senate resolution

II. Consideration of the concept of "uniformity"

III. Essay on the theoretical development of weights and measures as a function of man's natural history, of social needs, and of civil government

IV. The origins and development of systems of weights and measures

- A. Hebrew, Greek, and Roman weights and measures
- B. English weights and measures
    1. Basic principles
    2. Evolution of units and standards
    3. Present status
- C. The French metric system
    1. Basic principles
    2. Implementing the concept
    3. Present usage

V. Comparison of the English and metric systems and the advantages and disadvantages of each from the U.S. point of view

VI. Survey of the past and present status of weights and measures in the several States of the U.S.

VII. Alternative courses of action available to the Congress for securing uniformity among the States

VIII. Conclusions and recommendations

IX. Appendix: State-by-State survey of laws and practices with respect to the subject along with other supplementary material

The highlights of Adams' report can be examined best by following the outline of it [43].

After restating the main points to be addressed under the terms of the Senate resolution, Adams tackled the notion of uniformity of weights and measures in the abstract. He first pointed out that uniformity was a quality which might refer to several different aspects of weights and measures: the articles themselves, the objects to be weighed or measured, the duration of their establishment, the territory or people encompassed by a system of weights and measures, and so on. He further observed that uniformity, either partial or complete, might also be of two types—one of *identity*, the other of *proportion*. A uniformity of identity, upon which the French system was founded, was defined as one in which only one unit of weight is applied to all weighable articles, and so forth. The English system, on the other hand, was based on a uniformity of proportion, in which different units of weight and capacity might be used so long as they were related to one another in uniform proportions. This was an important distinction to Adams and he maintained it throughout his report.

With regard to the theoretical origins and development of weights and measures, Adams began with the needs of individual man,[3] and built up from that the additional attributes required of a system as civil society grew more complex. He next undertook an examination of the role of the legislator in the evolutionary process of weights and measures. Apparently basing his opinions on historical precedents as he perceived them, Adams was less than encouraging about the ability of lawmakers to effect the desired ends:

"When weights and measures present themselves to the contemplation of the legislator, and call for the interposition of law, the first and most prominent idea which occurs to him is that of *uniformity:* his first object is to embody them into a system, and his first wish, to reduce them to one universal common standard. His purposes are uniformity, permanency, universality; one standard to be the same for all persons and all purposes, and to continue the same forever. These purposes, however, require powers which no legislator has hitherto been found to possess. The power of the legislator is limited by the extent of his territories, and the numbers of his people. His principle of universality, therefore, cannot be made, by the mere agency of his power, to extend beyond the inhabitants of his own possessions. . . . The power of the legislator is limited over the will and actions of his subjects. His conflict with them is desperate, when he counteracts their settled habits, their established usages; their domestic and individual economy, their ignorance, their prejudices, and their wants; all which is unavoidable in the attempt radically to change, or to originate, a totally new system of weights and measures [44]."

"It is a consideration from which many important consequences result, that the proper province of law, in relation to weights and measures, is not to create but to regulate [45]."

[3] An example of Adams reasoning along these lines was included in ch. I under the heading of "Ancient Weights and Measures."

After briefly tracing the development of weights and measures that occurred under the Hebrews, Greeks, and Romans, Adams turned his attention to the English system, the French (metric) system and the effect of these two nations' cultures on the United States. He stated in advance the primary point which he was trying to make:

> "Both [England and France], for a series of ages, have been engaged in the pursuit of a uniform system of weights and measures . . . with efforts so stupendous and with perseverance so untiring, that, to any person who shall examine them, it may well be a subject of astonishment to find that they are both yet entangled in the pursuit at this hour . . . In the abstract, that system which would be most useful for one nation, would be the best for all. But this uniformity cannot be obtained by legislation. It must be imposed by conquest, or adopted by consent. When therefore two populous and commercial nations are at the same time forming and maturing a system of weights and measures on the principle of uniformity, *unless the system proves to be the same, the results as respects all their relations with each other must be, not uniformity, but new and increased diversity.*[4] . . . . The Congress of the United States have been as earnestly employed in the search of a uniform system of weights and measures as the British Parliament. Have either of them considered, how that very principle of uniformity would be affected by any, the slightest change, sanctioned by either, in the existing system, now common to both? If uniformity be their object, is it not necessary to contemplate it in all its aspects [46]?"

Following a thorough and detailed review of the basic principles, evolutionary developments and present status of both systems, Adams compared and contrasted the two systems to determine if the new French system demonstrated "some great and transcendent superiority" which would recommend it to the U.S. He listed five features which the metric system possessed which would qualify it as a superior system: (1) it was based on an invariable length standard taken from nature; (2) it utilized a single unit for weight measurement and a single unit for all measures of capacity, liquid or dry; (3) it was totally based on decimal arithmetic; (4) it was arranged so that coins and moneys of account were in proportion to each other and to the weights; and (5) its terminology was uniform, precise, and meaningful. These advantages were then analyzed and compared with their corresponding disadvantages.

Adams had two objections to the natural, invariable length standard. Unlike the customary system, he found, the metric system's standard could not even be closely approximated without recourse to a scientific operation. Also, the metric system's natural standard had not been practically used, even in France, by the geographers, astronomers, and navigators for whom it was designed.

[4] Emphasis added.

The advantage of having single units for all measures of weight and of capacity was, in Adams' opinion, offset by the fact that multiple units had come into being originally to take account of natural differences in the objects to be weighed and measured. The gallon of corn had been established as different from the gallon of wine because the measures by which solid and liquid substances were sold could not be conveniently combined (i.e., to suit the everyday purposes of the people). Adams went on to point out, however, that the U.S. would have less cause than other nations to regret the loss of this duality because "Wine is an article of importation; an article of luxury; . . . the exactness of the measure by which it is distributed, is not an incident which everyday comes home to the interests and necessities of every individual [47]."

The decimal base of the system, which Adams called "one of its highest theoretic excellencies," he thought had proved impracticable among the people of France. For retail trade purposes the more common divisions of 1/2, 1/3, 1/4, and so on were still widely used. For such purposes, he said, a base-12 system was inherently more suitable because the number 12 can be evenly divided by 2, 3, 4, and 6, whereas the number 10 is only divisible by 2 and 5.

The principle of maintaining a proportion between coins and weights he found to be a "great and solid advantage." To be deplored, however, was the way in which the French government had abused this principle by occasionally adjusting the value of its money.

Concerning the final superior advantage of the metric system—its nomenclature—Adams ruefully reported that this, the most significant contribution of all those offered, had failed to win popular acceptance in France. Earlier he had detailed the language problem in descriptive terms:

"So arbitrary and so irrational is the dominion of usage over the speech of man, that, instead of appropriating a specific name to every distinct thing, he is impelled, by an irresistible propensity, sometimes to gives [sic] different names to the same thing, but far more frequently to give the same name to different things . . . When man first borrows from his own person a standard measure of length, his first error is to give to the measure the name of the limb from which it is assumed . . . Of all the tangles of confusion to be unravelled by the regulation of weights and measures, these abuses of language in their nomenclature are perhaps the most inextricable [48]."

Unfortunately, in Adams' opinion, the solution offered by the metric system—which would have required the people to use only 12 new terms—had not been taken up in France, but, instead, had been repealed by Napoleon's 1812 decree.

A unique feature of Adams' consideration of the metric system was his recognition of the fact that, regardless of the eventual disposition of the new system, the body of scientific knowledge possessed by man had been increased simply by carrying out the operations necessary to the determination of new standards. This "by-product" effect of the French experiments was not specifically alluded to by any other student of the subject for generations after Adams. The two contributions named were: (1) the determination of the extent of the flattening of the earth at the poles caused by axial rotation with unprecedented accuracy; and (2) the redetermination of the temperature at which water has its greatest density.[5] These advances resulted, respectively, from the survey work done as the basis for constructing the meter and the experiments conducted in determining the kilogram. Their inclusion in Adams' report is an indicator of the depth of his investigation.

It should be emphasized that Adams fully appreciated the metric system as an abstract concept and he praised it accordingly:

> "The system approaches to the ideal perfection of *uniformity* applied to weights and measures; and, whether destined to succeed, or doomed to fail, will shed unfading glory upon the age in which it was conceived, and upon the nation by which its execution was attempted [49]."

> "Considered merely as a labor-saving machine, it is a new power, offered to man, incomparably greater than that which he has acquired by the new agency which he has given to steam. It is in design the greatest *invention* of human ingenuity since that of printing [50]."

But he did not believe that the system had yet attained sufficient maturity to recommend its adoption by the U.S. in 1821.

> "It results, however, from this review of the present condition of the French system in its native country, and from the comparison of its theoretical advantages over that which we already possess, that the time has not yet arrived at which so great and hazardous an experiment can be recommended, as that of discarding all our established weights and measures, to adopt and legalize those of France in their stead [51]."

One of the reasons why this conclusion had to be drawn was that Adams' survey of the existing situation in each of the 22 States of the Union had revealed that substantial uniformity already existed throughout the U.S. (with the exception of predominantly-French Louisiana). With the Supreme Court just beginning to become embroiled in questions of States' rights, he was reluctant to recommend any action that tended to nullify State laws.

After summarizing the results of this survey on a State-by-State basis,[6] Adams stated his opinions as to the extent of the authority to act that had been granted to the Congress by the Constitution:

> "It may admit of a doubt whether under this grant of power is included an authority so totally to subvert the whole system of weights and

[5] This significant discovery exploded the supposition that the freezing point of 32 °F was that at which maximum density existed. Gineau and Fabrioni, who did the work, found it to be a full 9° higher. Through improved scientific methods, this value has since been refined to about 39+°F. The shattering of the old assumptions, however, was the important contribution made by these scientists.

[6] The details of the survey are included in a 108-page appendix to the Report.

> measures as it existed at the time of the adoption of the constitution, as would be necessary for the introduction of a system similar to that of the French nation. To *fix* the standard, appears to be an operation entirely distinct from changing the denominations and proportions already existing, and established by the laws, or immemorial usage [52]."

Nevertheless, Adams did not presume a total lack of authority when laying out the four different courses of action he thought were available to the Congress:

1. "To adopt, in all its essential parts, the new French system of weights and measures founded upon the uniformity of identity.
2. "To restore and perfect the old English system of weights, measures, moneys, and silver coins, founded upon the uniformity of proportion.
3. "To devise and establish a system, in which the uniformities of identity and of proportion shall be combined together, by adaptations of parts of each system of the principles of the other.
4. "To adhere, without any innovation whatever, to our existing weights and measures, merely fixing the standard [53]."

Adams analyzed each of these options in turn as to their advantages, disadvantages, and the extent of the action implied if Congress were to undertake it.

His opinions concerning the first possible course of action, adoption of the metric system, have already been noted. Restoration of the *old* English system (that going back almost to Saxon times), Adams believed, "would require an exercise of authority no less transcendent than the introduction of the French system [54]." The idea of devising a "hybrid" system he dismissed as unneccessary and not productive of sufficient improvement. In the end, therefore, he favored giving legislative approval to the existing system of weights and measures, but without closing the door to the possibility of future changes.

His ultimate recommendations were:

1. "That the President of the United States be requested to communicate, through the ministers of the United States, in France, Spain, and Great Britain with the governments of those nations, upon the subject of weights and measures, with reference to the principle of uniformity as applicable to them;" [55] and
2. "In the mean time, should Congress deem it expedient to take immediate steps for accomplishing a more perfect uniformity . . . it is proposed that they should assume as their principle, that no innovation . . . should be attempted [56]."

Should Congress decide to accept his latter proposal, Adams suggested that they (1) declare what the legal weights and measures were to be; (2) procure U.S. standards, made of a suitable metal, to be deposited in Washington, D.C.; (3) furnish the Governor of each State with copies of the standards; (4) require the Federal Government to use the standards in its custom houses, land surveys and public offices; and (5) prescribe penalties for the use of any other weights and measures with intent to defraud.

Finally, Adams proposed a plan for carrying out each of the above suggestions. Defining the units of the system in terms of the British exchequer standards, he recommended that the U.S. obtain official standards by making a copy of the standard yard of 1601, and by using that copy to construct suitable capacity standards. Copies were also to be made of the avoirdupois and Troy pounds in the exchequer. He further proposed that the new U.S. standard be compared to the French meter to determine the exact ratio between the two and suggested that this relationship be specified in the act defining U.S. standards.[7] Adams rejected the notion of using a pendulum as the standard because, he felt, neither the French meter nor the English yard would ever be defined by use of a pendulum. This was done by Adams in spite of the fact that while he was preparing his report Jefferson had written to him, again urging the pendulum principle and the convenience of decimal ratios [57].

In his concluding summary, Adams noted that the two parts of the plan he had recommended were distinct from each other and could be executed separately. However, he cautioned that "If there be one conclusion more clear than another, deducible from all the history of mankind, it is the danger of hasty and inconsiderate legislation upon weights and measures [58]."

His closing remarks were at once a synopsis of Adams' considered opinion and a portent of things to come:

> "The glory of the first attempt [to establish uniformity] belongs to France. France first surveyed the subject of weights and measures in all its extent and all its compass. France first beheld it as involving all the interests, the comforts, and the morals, of all nations and of all after ages. In forming her system, she acted as the representative of the whole human race, present and to come. She has established it by law within her own territories; she has offered it as a benefaction to the acceptance of all other nations. That it is worthy of their acceptance, is believed to be beyond a question. But *opinion* is the queen of the world; and the final prevalence of this system beyond the boundaries of France's power must await the time when the example of its benefits, long and practically enjoyed, shall acquire that ascendency over the opinions of other nations which gives motion to the springs and direction to the wheels of power [59]."

F. THE IMPORTANCE AND IMPACT OF ADAMS' REPORT

In addition to the influence of John Quincy Adams' report on the arguments used in constructing pro- and anti-metric cases in later years, the

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[7] As a matter of interest, the current U.S. standards are those of the Système International. The yard, the pound, etc. exist only as internationally agreed-upon relationships to those standards.

document is noteworthy on several counts. First of all, it represents the first serious and thorough consideration of the possibility of U.S. adoption of the metric system. The attention paid to the system and the praise lavished on it by Adams are indications of the progress that had been made by this innovation in the relatively short time since its inception. Considering the political turmoil which was going on at the same time (a condition far from conducive to international cooperation on such matters), it is remarkable that Adams should have seen as much future potential in the metric system as he did.

A second point which should be noted is that the majority of Adams' doubts about the practicability of the system stem from the fact that the system had been "altered" by Napoleon in 1812. As it was not officially reinstated as the only legal system in France until 1837, it was natural for Adams to construe the present situation as representing a "failure" to gain popular acceptance. In fact, it did take a long time for the metric system to take hold, even in France.

Adams' recommendations were also made in the context of the existing situation in the United States. His survey of that situation was no less thorough than the rest of the report, and was to stand as the only comprehensive study of State weights and measure laws for many years to come. His survey disclosed: (1) that most of the States had already provided for use of the English system by law; and (2) that the lack of suitable standards and official definitions for weights and measures indicated what action was most needed. Not wanting to upset a system already in place, given that his objective was to recommend a plan for achieving uniformity, considering that the bulk of U.S. commercial dealings still were with Great Britain, and taking into account the fact that France apparently had abandoned the metric system, Secretary Adams' recommendations can only be thought of as having been formulated from a realistic point of view.

To the detriment of the metric system's chances for early adoption in the U.S., Adams' report had the effect of closing out further consideration of the system in the U.S. for 40 years. During that time, while the metric system was being picked up by one nation after another, the United States was expanding its frontiers, constructing the most elaborate transportation network in the world, erecting factories at a frantic pace, and developing an engineering system to go with it that was second to none. It is small wonder then, that when the question of metric adoption was raised in the early part of the 20th century the engineering and manufacturing interests in the United States were inclined to be opposed to the proposition.

G. SOME TEMPORARY MEASURES AND A LENGTHY INTERLUDE

When received by the Congress, Adams' report was referred to a committee of the House which, on March 11, 1822, recommended that the President have true replicas of the English standards constructed and copies of them distributed to the States [60]. This suggestion was never adopted.

Four years passed before Congress returned to the subject. When it did, on May 16, 1826, an entirely different proposition was put before the House by Representative William Czar Bradley [61]. His Committee on Weights and Measures was recommending a resolution requiring experiments to be made:

> "For the purpose of ascertaining the true length of the pendulum, vibrating 60 times in a minute, at the city of New York, and also at the city of Washington, and to compare the length thereof with such measures, now in the possession of this Government, as will best show the proportions between the length of such pendulums and the standard yard recently adopted by the British Government [62]."

This proposition was occasioned by a British action adopting the standard yard of 1760 as the basis for all measures of length, weight, and capacity. At the same time, Great Britain had defined its new standards in terms of a pendulum vibrating seconds in London. Representative Bradley's proposal was aimed at establishing complete uniformity with the English standards. This was to be done by duplicating the British experiments in two places, making a total of three different measurements of the same phenomenon. While Bradley's idea was never enacted into law, the debate in the House on the resolution revealed a serious deficiency in the existing situation with respect to weights and measures in the United States. The Committee's investigation had included a survey of United States custom houses and their inquiry had revealed that discrepancies in the standards used in the various parts of the country had caused a significant loss in revenue.[8]

Four years later, on May 29, 1830, this matter was again called to the attention of Congress, and the following resolution was approved by unanimous consent:

> "*Resolved,* That the Secretary of the Treasury be directed to cause a comparison to be made of the standards of weights and measures now used at the principal custom houses in the United States, and report to the Senate at the next session of Congress [64]."

This work was done by Ferdinand Hassler of the Coast Survey and the results, showing large variations in the values of weights and measures used from place to place, were transmitted to Congress in 1832. The Secretary of the Treasury, Louis McLane, believed that his Department had sufficient authority to correct the problem without further legislation. As a consequence, Mr. McLane instructed Hassler to have uniform and accurate standards of weights and measures supplied to all the custom houses. As the basis for these standards, McLane, without legislative sanction, adopted the yard, the avoirdupois pound, and the Winchester bushel. The Troughton scale referred to earlier was used in constructing the standard of length, while the avoirdupois pound standard was fabricated by using the Mint's Troy pound [65].

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[8] It was estimated that the amount of revenue lost each week would more than cover the cost of establishing uniform standards [63].

The Troy pound had been procured in 1827 by Albert Gallatin, minister of the United States at London, and brought to this country by special messenger, who delivered it to the director of the Mint at Philadelphia [66]. On May 6, 1828, a bill was introduced in the House to continue operation of the Mint and to establish the Troy pound procured the year before as "the standard . . . of the Mint of the United States, conformably to which the coinage thereof shall be regulated [67]." This Act was passed on May 19,1828, and the U.S. had, after 45 years of independent existence, finally adopted a standard of weight for its coins. It had also passed the first, and only, law of the United States officially adopting a standard of the customary system of weights and measures.

As if to prod the executive branch into faster action on the custom house problem, a resolution was introduced in the House in 1835 declaring it to be "highly expedient that the Treasury Department should complete, with as little delay as practicable the fabrication of standards . . . for the supply of the different custom houses [68]."

Nothing resulted from this proposal, but the following year a joint resolution was approved,[9]

> "That the Secretary of the Treasury be, and he hereby is, directed to cause a complete set of all weights and measures adopted as standards and now either made or in progress of manufacture for the use of the several custom houses, and for other purposes, to be delivered to the Governor of each State in the Union, or such person as he may appoint, for the use of the States, respectively, to the end that a uniform standard of weights and measures may be established throughout the United States [69]."

A similar resolution requiring balances to be furnished to the States was passed in 1838. By 1850 this work had been completed and, one way or another, most of John Quincy Adams' second propostion had been executed. Action along the lines of his first recommendation—international collaboration—was not to occur until the 1870's, and only then at the initiation of the French Government.

To all intents and purposes the joint resolutions of 1836 and 1838 closed the books on congressional legislation with respect to weights and measures for 30 years. The next action of note was not taken until 1866. Although the United States did acquire new copies of the English standards in 1856, no further action to *fix* the standards or to adopt a system *in toto* to achieve uniformity was forthcoming for awhile. Thus the first major period in the evolution of U.S. weights and measures had come to an end. When the matter was next reopened, it was because the international use of the metric system had grown too large to ignore any longer.

[9] On June 14, 1836.

III. AN ACT TO AUTHORIZE THE USE OF THE METRIC SYSTEM (1861-1866)

Prior to the American Civil War not one piece of legislation calling for U.S. acceptance of the metric system had even been introduced in Congress. Then, in 1866, an Act was passed without resistance or fanfare making it legal to use the system for the transaction of any and all business in this country. This was a major turning point in the history of U.S. weights and measures. Whereas previous legislative proposals had been directed either to the problem of uniformity or the Congressional charter to fix the standard, the emphasis from this point forward was to be on deciding which *system* should be the one officially sanctioned by the American Government. The story of how this Act came into being is brief, but the consequences of its enactment would be felt for many years.

A. THE CURRENTS OF CHANGE

The ideas advanced by John Quincy Adams in 1821 proved to be premature. Although his words were often invoked in later years as authoritative evidence both for and against the adoption of the metric system, they were largely ignored by his contemporaries. The most urgent needs in the weights and measures field—a standard for coins, correcting deficiencies in custom house operations, and providing for uniform State standards—had been met by a combination of stopgap procedures. For this reason, there was no pressing demand for further action on weights and measures by the Congress for several years.

During this time the metric system was gaining in international stature. France had restored its compulsory status in 1840, and Napoleon's conquests had forced several of her immediate neighbors (including Belgium, the Netherlands, Greece, Sardinia, and Spain) to recognize early the efficacy of keeping in step with France for commercial dealings. The system was also made to order for scientific work, and the acute need for a universal language of science was beginning to be felt by 1850. It was this need that eventually culminated in the Act of 1866.

The United States was ambivalent on this matter between 1821 and 1863, and it is very difficult to find a consistent pattern in the events of the period that might be called anything like a trend. Nevertheless, the slow drift of the United States in the direction of the metric system may be traced back to the 1840's and a man named Alexander Dallas Bache (1806-1867). In 1843 Professor Bache, a great-grandson of Benjamin Franklin and already a scientist and educator of some prominence, was appointed to succeed Ferdinand Hassler as the Superintendent of the Coast Survey [1]. This position carried with it at that time the responsibility for the Office of Weights and Measures. Thus it fell to Bache to carry out the work of making and distributing to the States the copies of the Treasury Department's standards as required by the Congressional resolutions of 1836 and 1838. In the process of doing this work, and perhaps owing also to his studies in Europe from 1836 to 1838, Bache became dissatisfied with American adherence to the customary system of weights and measures.

He also managed to impress his superiors with the strength of his convictions, as evidenced by Treasury Secretary R. J. Walker's 1847 report to the Congress. In laying the issue before them Walker observed:

> "Coins, as well as weights and measures, for the benefit of all nations, ought to be uniform throughout the world; and if our decimal system of coinage should be more simple and perfect than that of any other nation, it ought to be, and ultimately will be, adopted, and lead as far as practicable to the introduction of the decimal system of weights and measures, or at least its simplification, so that ultimately the coin and the weights and measures may be simple and uniform throughout the world [2]."

Professor Bache pursued this point 6 months later in his own message to the Congress when, after reporting the progress which had been made in distributing standards to the States, he complained:

> "No one who has discussed the subject of weights and measures in our country has considered the present arrangement an enduring one. It has grown up with the growth of European society, and is deficient in simplicity and in system. The labor which is expended in mastering the complex denominations of weights and measures is labor lost. Every purpose for which weights and measures are employed can be answered by a simple and connected arrangement [3]."

Following a brief review of Adams' proposals, particularly his suggestion on international collaboration, Bache noted:

"The present time seems especially to invite an effort of this kind. In England the subject of weights and measures is under consideration by a commission, and on the continent the new relations of States hitherto separated appear to be favorable to this object. Such changes could readily be effected by suitable means in one generation by introducing the new measures through the elementary schools [4]."

In a subsequent report, he more clearly spelled out the details of his proposal as well as the impetus behind it:

"By reference to the interesting account of the metrical system . . . it will be seen that it has extended widely beyond the boundaries of France . . . Has not the time arrived, in the general progress of commercial and international intercourse, and the rapid advance of our own country in science, wealth, and power when her voice should be heard in an important matter like this? Should not Congress make the proposition to all nations to meet by their representatives, and consult for the purpose of establishing permanent and universal uniformity of weights and measures [5]?"

In addition to increased international acceptance of the system, one of the things which undoubtedly caused the issue to be raised about this time was the British Government's abandonment of the Troy scale of weight measurement in 1841 [6]. This placed the coinage systems of France, Great Britain, and the U.S. on entirely different weight bases. Also, Great Britain was in the process of fabricating a new length standard at the time. The British activity in weights and measures was necessitated by the destruction of its old (1758) standards in the 1834 burning of the Parliament buildings. When the new standards were completed in 1855 two copies of the yard and one copy of the avoirdupois pound were given to the United States, arriving here in 1856 [7]. The concerted action recommended by Bache was never approved by a Congressional mandate, however.

In the meantime, other events were occurring abroad which are worthy of note. In 1851 the first great international exhibition was held in London and in 1855 another took place in Paris. At both of these events the diversity of weights and measures used from country to country was open to display and even caused inconvenience to the judges [8]. As the result of a statistical conference held concurrently with the 1855 Paris exhibition, about 150 of the delegates banded together to found the International Association for Obtaining a Uniform Decimal System of Measures, Weights and Coins [9]. The most active Branch of the Association, and there were branches in 15 nations, was the British Branch. Its investigations of various alternative decimal systems soon led the group to settle on the metric system, thus becoming the first avowedly pro-metric "promotive organization [10]." When other nations rapidly began adopting the metric system from this point on, the British Branch of the Association was able to place the issue before the House of Commons. In 1863 a bill favoring the introduction of the system was passed by that body but not taken up in the House of Lords

[11]. The next year—1864—the Association renewed its efforts and, by picking up the support of the British Association for the Advancement of Science was instrumental in getting enacted the first British bill making use of the system "permissive [12]." Although this Act did not prove satisfactory for very long, it had a distinct influence on the Congress of the United States in 1866.

Returning to the consideration of the subject in the United States, the currents of change were unmistakable by the mid-to-late 1850's. In 1854, the American Geographical and Statistical Society sent a memorial to Congress requesting that an international scientific commission be formed to consider a uniform decimal system of weights and measures [13]. Then, in 1859, the legislature of New Hampshire required their delegation to urge upon Congress the adoption of a decimal system [14]. The neighboring State of Maine, on March 20, 1860, joined the crusade by expressing their desire for adoption of the uniform international system of weights, measures, and coins [15]. Connecticut concurred with this action in 1861 and also provided, in 1864, for teaching the metric system in all the schools of that State [16].

Although the attention of Congress was almost totally absorbed by the Civil War before these resolutions could be acted upon, the subject was not allowed to drop. In 1861 the Secretary of the Treasury, Salmon P. Chase, again used his annual report to the Congress as a vehicle for urging a change in the American system of weights and measures:

> "The Secretary desires to avail himself of this opportunity to invite the attention of Congress to the importance of a uniform system, and a uniform nomenclature of weights, measures, and coins, to the commerce of the world, in which the United States already so largely shares. The wisest of our statesmen have regarded the attainment of this end so desirable in itself as by no means impossible. The combination of the decimal system with the appropriate denominations in a scheme of weights, measures, and coins for the international uses of commerce, leaving, if needs be, the separate systems of nations untouched, is certainly not beyond the reach of the daring genius and patient endeavor which gave the steam-engine and the telegraph to the service of mankind. The secretary respectfully suggests the expediency of a small appropriation to be used in promoting interchange of opinions between intelligent persons of our own and foreign countries on this subject [17]."

But again the times were not propitious for a collaboration with either Great Britain or France. Great Britain had recognized the belligerent status of the Confederate States of America and, to the consternation of the Union, continued to trade actively with them and even supplied gunboats in support of the cause. On her part, France had also taken advantage of the split to install the puppet Emperor Maximilian in Mexico. These diplomatic problems, combined with the war, certainly made uniformity of weights and measures a low-priority item on the legislative agenda prior to 1866.

Taking into account all of the turmoil in the U.S. during these years, the events which were about to occur represent truly remarkable achievements.

B. THE METRIC SYSTEM ACQUIRES SPONSORSHIP: 1863-1864

The legalization of the metric system by the U.S. was hastened by two international conferences in 1863 and by two Congressional moves in 1863-1864.

On the international scene, a postal congress and another international statistical congress adopted resolutions which further secured the position of the metric system as the internationally-preferred one. At the postal congress, held in Paris in May, 1863,[1] the following resolutions were approved:

"SEC. 7. The rates upon international correspondence shall be established according to the same scale of weight in all countries.

"SEC. 8. The metrical decimal system, being that which best satisfies the demands of the postal service, shall be adopted for international postal relations, to the exclusion of every other system.

"SEC. 9. The single rate upon international letters shall be applied to each standard weight of 15 grams, or fractional part of it [18]."

While this action was significant in and of itself, it should also be noted that the U.S. Commissioner to the congress was John A. Kasson of Iowa, a former First Assistant Postmaster General in Lincoln's administration, who was soon to become a leading advocate of the metric system. In 1864 Kasson was to achieve an office from which he could effectuate his ideas on weights and measures reform.

At the statistical conference, held in Berlin in late 1863, the delegates resolved that the adoption of the same system of weights and measures for commercial dealings was of the highest importance and that the metric system was the most convenient [19]. A full report of the meeting, which included detailed information on the weights, measures, and coins of all European and several American nations, was rendered to Congress in June, 1864, by the U.S. representative, Samuel B. Ruggles.

Also in 1863 a third event occurred which was to have a profound impact on the decision to authorize the use of the metric system in the U.S.—by Act of Congress the National Academy of Sciences was founded. This body, authorized "to investigate, examine, experiment and report upon any question of science and art" might naturally be inclined to favor the metric system reform in any case, but the prime mover behind the Academy (and its first President) was a man who did not leave such things to chance. This was none other than Alexander D. Bache. In spite of the fact that the new organization was hastily formed and ran into difficulties in its early years (the enabling Act was passed almost unwittingly, in a flurry of lame-duck session legislation; the balance of disciplines among the original 50 members

[1] The U.S. Government initiated this conference, which was attended by nearly all the European nations and some American countries.

was lopsided in favor of the physical sciences; and at least three notable scientists were not chosen for membership due to personality conflicts [20]) it managed to get around to weights and measures very early. In fact, the first committee established by the Academy was that on Weights, Measures, and Coinage. It was appointed on May 4, 1863 at the request of Treasury Secretary Chase, and was originally made up of eight members under the chairmanship of the eminent Joseph Henry, first Secretary of the Smithsonian Institution [21]. Among the members of the Committee were Bache and Samuel B. Ruggles. Although this Committee did not complete their work before being replaced by a permanent committee in 1866, they apparently got to the heart of the matter very quickly. As Professor Bache related in his first report as President of the Academy:

> "The discussions in the body of this committee were strongly in favor of the adoption of the French metrical system, but more strongly, in fact unanimously, in favor of the effort to arrive at a thorough international system—a universal system of weights, measures, and coins, available for the general acceptance of all nations [22]."

Long before this committee submitted its first report, in January 1866, Congress had also given formal recognition to the importance of the question.

On January 21, 1864, the House of Representatives adopted a resolution creating a new standing committee—the Committee on a Uniform System of Coinage, Weights and Measures.[2] This Committee was the product of efforts by the same John A. Kasson of Iowa who had represented the United States at the International Postal Congress the previous year. Mr. Kasson, now a member of Congress, was selected as the Committee's first chairman.

That the committee believed its role to be that of bringing about weights and measures reform is clearly revealed in its 1866 report:

> "[T]he House of Representatives . . . by an amendment of its rules [established] a standing committee to take jurisdiction of this great reform. As efforts to carry that reform into effect had hitherto been spasmodic rather than consecutive, it was thought proper thereafter to crystallize them through the action of a permanent committee, before whom they should perpetually reappear until the conceded great desideratum should become an accomplished fact [23]."

And the subject did perpetually reappear before this Committee. Until its abolition by a legislative reorganization in 1946, this Committee served as the main battleground on which metric contests were fought. It also wound up being the final resting place for most metric bills. Even though the Committee scored most of its successes with metric legislation in the first 2 years of its existence, its effectiveness and important contributions cannot be dismissed. During its 82-year history, for example, it was responsible for the

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[2] In 1866 the name was changed to the Committee on Coinage, Weights and Measures, and it is by this name that it will appear throughout the remainder of this account.

enactment of a number of significant pieces of much-needed weights and measures legislation, figured prominently in the gold *vs.* silver bimetallism coinage controversy of the late 1800's, and sanctioned the establishment of the National Bureau of Standards, several assay offices and a branch mint at Omaha, Nebraska [24]. Thus the nature of Congressman Kasson's contribution to American weights, measures, and coinage went far beyond the initially-stated objective of securing international uniformity even though this ultimate purpose of the Committee on Coinage, Weights, and Measures was never achieved.

If Mr. Kasson was not already a staunch supporter of the metric system of weights and measures as the surest means of securing international uniformity he was soon to become one. And he was to remain one throughout his extremely long (1822-1910) life. In the midst of a busy career, which included service in the 38th, 43rd, 44th, 47th, and 48th Congresses and ambassadorships to Austria-Hungary and Germany [25], Representative Kasson managed to find the time to serve as the Vice President of the American Metrological Society—a professional group with an avowed pro-metric bent—from 1873 through 1877. To him belongs most of the credit for the enactment of the 1866 Act legalizing the use of the metric system.

The new Committee wasted no time in setting about its coinage work. In 1864 three bills were reported by the Committee and eventually enacted into law. The first of these was a requirement that pennies be made of copper instead of the previously-used nickel [26]. The others were bills to control counterfeiting [27] and to facilitate the exchange of gold bullion for coin [28]. Two years later, the metric system was considered by a Committee of Congress for the first time.

C. 1866: A REFORM INITIATED

In January, 1866, the National Academy of Sciences' Committee on Weights, Measures, and Coinage submitted its first report. In transmitting the report to Secretary of the Treasury McCulloch, the Chairman, Joseph Henry, was careful to emphasize the opinions of the minority, which were not in the report:

"The subject is one of much perplexity. While, on the one hand, it is evident that a reform of our present system of weights and measures is exceedingly desirable, on the other, the difficulty of adopting the best system and of introducing it in opposition to the prejudice and usages of the people is also apparent.

The entire adoption of the French metrical system involves the necessity of discarding our present standard of weights and measures—the foot, the pound, the bushel, the gallon—and the introduction in their place of standards of unfamiliar magnitudes and names.

Such a change, in my opinion, can only be, in a government like ours, the work of time and through the education of the rising generation. For this purpose, should the resolution now before Congress to establish a bureau of education be adopted, the French metrical system might be taught under the sanction of the government in all the common schools of the country.

The system, however, is not considered by many as well adapted to the Anglo-Saxon mind as one which might be devised, and it was therefore the opinion of a minority of the academy, that, could England and the United States agree upon a system for adoption, it would in all probability in time become universal [29]."

The actual report of the Academy's committee was far more favorable toward the proposition of taking positive action with regard to the metric system:

"The Committee are in favor of adopting, ultimately, a decimal system; and, in their opinion, the metrical system of weights and measures, though not without defects, is, all things considered, the best in use. The committee therefore suggest that the academy recommend to Congress to authorize and encourage by law the introduction and use of the metrical system of weights and measures [30]."

The committee also recommended that Congress provide for the construction of metric standards and their distribution to the States and custom houses; that the metric system be introduced in the post offices of the U.S.; and that new cent and two-cent pieces be so coined that they weighed 5 grams and 10 grams respectively and have diameters related to metric length units [31].

Accordingly, two bills and two joint resolutions were introduced in the first session of the 39th Congress and considered by the House Committee on Coinage, Weights, and Measures:

(1) *H.R. 140,* a joint resolution authorizing and directing the Secretary of the Treasury to furnish each State with one set of standard weights and measures of the metric system.

(2) *H.R. 141,* a joint resolution authorizing the President to appoint a special commissioner to negotiate with foreign governments regarding the establishment of a common unit of money having an identical value in all nations.

(3) *H.R. 597,* a bill authorizing and directing the Postmaster General to furnish postal balances denominated in grams to all post offices exchanging mail with foreign countries and to such other post offices as he believed expedient.

(4) *H.R. 596,*[3] a bill declaring it lawful throughout the United States of America "to employ the weights and measures of the metric system." Further provisions specified that no contract dealing, or court proceeding could be deemed invalid or liable to objection because of the use of metric denominations. Tables specifying the

[3] This bill, the Committee's *piece de resistance,* originally had been introduced as H.R. 252, proposing the compulsory and exclusive use of the metric system after a brief transition period.

English-system equivalents of metric measurement units and values were also included in the bill.

All of these bills were reported favorably by Mr. Kasson on behalf of the committee on May 17, 1866. In the report were listed the documents and historical factors which had influenced the committee to recommend passage of the above bills. In addition to several memorials and petitions favoring the metric system, the committee specifically took note of the reports of the National Academy of Sciences and Commissioner Ruggles' report on the 1863 Berlin statistical congress. The committee next took up separately the questions of coinage and of weights and measures.

"In respect to the gold and silver coins of the United States," the committee found, "no specific change can, with propriety, be recommended for immediate adoption [32]." Singling out the question of how a common standard of international values for coins could best be established as the main problem, the committee noted that:

"The occasion of the World's Exposition of Industry at Paris in 1867 will furnish the proper opportunity for a free conference between the authorized commissioners of different governments as to the best means of establishing a uniform system of coinage for the common use of the nations of the world. It is to be hoped that the government of the United States will be represented by a commissioner whom it may be authorized to delegate, with special reference to the accomplishment of this great object . . . No opportunity so auspicious for effecting any needed change in quantity of gold or silver, and alloy, can be expected for many years to come [33]."

To pursue this opportunity, H.R. 141 was offered authorizing the President to appoint a special commissioner to negotiate an agreement with the leading nations of Europe.

The Committee's discussion of weights and measures problems was more elaborate and their recommendations more definite. Their first object of consideration in this respect was a review of the previous work undertaken on weights and measures. The matter was introduced as follows:

"The whole history of our revolutionary confederation, and of the constitutional government of the United States, has been a continuous acknowledgment of the perplexities arising from the diversity of weights and measures throughout their jurisdiction, and of the great desirableness of a uniform and a decimal system [34]."

After giving the details of Thomas Jefferson's plans and the activities surrounding it, the Committee report presented John Quincy Adams' arguments and recommendations. It is clear from this report that Adams' influence had spanned the intervening years and provided the 1866 Committee with a potent stimulus to act favorably on the question of weights and measures reform:

"[T]he separate action of foreign governments . . . has produced the results which the Secretary sought by his proposition for concurrent action. The desire he expressed for the concurrence of the British government especially is now realized in the initiatory steps taken by Parliament in the authorized adoption of the metric system.

[T]he second part of Mr. Adams's plan has not been effectively prosecuted. Its objects, however, have not been forgotten, and have occupied, during the last 10 years more especially, the serious attention of the people and the government. Resolutions of State legislatures, petitions from scientific and other organized societies, recommendations from executive officers, and direct action of Congress—all these indicate a dissatisfaction with the present defective system of our weights and measures and an earnest desire for a decimal system common to all nations [35]."

The Committee then completed its survey of the history of U.S. weights and measures, bringing the situation up to the present by reviewing the more recent proposals and activities—beginning with Secretary Walker's 1847 report to the Congress and concluding with an account of the committee's own establishment.

To provide additional justification for its case in favor of the proposed legislation the House Committee also surveyed the status of the metric system in other nations of the world. Particular attention was paid to the importance of Britain's having enacted similar legislation only 2 years earlier. The following paragraph from the Committee's report was intended to explain the significance of the international situation. Without realizing it, however, the committee was also summarizing what was to become the principal case of metric advocates for more than 60 years:

"Our predecessors of the era of Mr. Adams found the interests of this country much more dependent upon England than they are at this day. England herself was less subject at that time to the effect of foreign influence than at present. The *failure of these two governments to unite upon a system resting upon a standard of their own,* at a time when France stood alone for the metric system *has been fatal to the adoption of the arbitrary system of those countries* by other nations. Convinced of its imperfections, *no effort was made to introduce it into other countries,* and any modification of it with a view to its improvement *would only have created an additional system* to those already in use in the world *without having in any of its features a superiority over the metric system.* In the mean time, the *simple order, beauty, and convenience of the metric system* has so commended it to universal acceptance that *it has already been adopted exclusively or permissively by nearly all the nations* of christendom [36]." [4]

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[4] Emphasis supplied.

The Committee on Coinage, Weights, and Measures concluded its defense of the recommended legislation by making a verbal comparison of the English and metric systems, outlining the salient features of each and pointing out the advantages offered by the metric system.

For some reason, perhaps because of the doubts expressed by the National Academy of Sciences, the Committee declined to go so far as to set a date by which use of the system ought to become mandatory. This point was addressed specifically in both the introduction to the report and in the final summary:

"[Your Committee] do not doubt that a subsequent Congress will be prepared to go further, and will enable the republic to lead, rather than to follow, the action of other commercial and intelligent nations in the complete establishment of this most urgently demanded reform. It is an obligation we owe not only to our present convenience, but also to posterity to whose benefit all sound reforms invariably tend [37]."

"They were not prepared to go, at this time, beyond this stage of progress in the proposed reform . . . . It is therefore very important to legalize its use, and to give to the people, or that portion of them desiring it, the opportunity for its legal employment, while the knowledge of its characteristics will be thus diffused among men. Chambers of commerce, boards of trade, manufacturing associations, and other voluntary societies, and individuals, will be induced to consider and in their discretion to adopt its use. The interests of trade among a people so quick as ours to receive and adopt a useful novelty, will soon acquaint practical men with its convenience. When this is attained—a period, it is hoped, not distant—a further Act of Congress can fix the date for its exclusive adoption as a legal system. At an earlier period it may be safely introduced into all public offices, and for government service [38]."

When Mr. Kasson brought this bill and the three accompanying it to the floor of the House of Representatives, the only one severely questioned was H.R. 141—the resolution appointing a uniform coinage commissioner. The main objection to this proposal was simply that 10 commissioners had already been appointed to the Paris Exhibition, and Mr. Lawrence, a Representative from Ohio, was strictly opposed to another "unnecessary officer, entailing an unnecessary expense [39]." In the end, all four bills were passed by the House and sent to the Senate on May 17, 1866.

On the Senate side of the Capitol, H.R. 596 and its companions were referred to a Select Committee on Coinage and Weights and Measures, from which they were reported without amendment on July 16. Eleven days later the bill was considered and passed. The Senate debate appears to have provided the occasion for quite lengthy remarks in favor of the bill by Senator Charles Sumner of Massachusetts, Chairman of the Select Committee, although the remarks immediately preceding and following this speech in the record would indicate that Senator Sumner either summarized his views at that time or simply ordered them to be inserted in full in the record [40]. Senator Sumner also reviewed the history of previous attempts to bring about weights and measures reform, placing his main emphasis on (1) the features built into the metric system which made it superior for scientific work, and (2) the fact that so many other nations, but especially Great Britain, had already accepted the metric system. Like his colleagues on the House Committee, Senator Sumner believed that the pending legalization would hasten the metric system's ultimate acceptance for all purposes:

> "By these enactments the metric system will be presented to the American people, and will become an approved instrument of commerce. It will not be forced into use, but will be left for the present to its own intrinsic merits. Meanwhile it must be taught in schools. Our arithmetics must explain it. They who have already passed a certain period of life may not adopt it; but the rising generation will embrace it and ever afterwards number it among the choicest possessions of an advanced civilization [41]."

On the same day the Senate passed the two bills and the resolution to distribute metric standards to the States. The following day, July 28, 1866, they were signed into law by President Andrew Johnson.

D. A PERSISTENT NOTION

Even though the metric system had been officially sanctioned under the law of the land, its legislative history was just beginning. The matter reappeared less than 15 years later, this time with more assertive provisions included in the legislation proposed. In view of the supposedly overwhelming demand for some action to correct the existing deficiencies in U.S. weights and measures, questions naturally arise as to why any additional legislation should be required so early and what the results of the laws enacted in 1866 were. There are many answers, but none of them is that what the Congressional sponsors of the legislation foresaw—that is, a growing popular demand creating a favorable climate for compulsory adoption of the system—had come to pass.

For one thing, the demand for action was coming from a small segment of the population—mostly scientists and government officials. In fact, there were just two men, Bache and Kasson, who, through dedication and a sincere belief in the need for reform, were truly committed to the proposition of metric legislation in 1866.

In addition, the passage of the 1866 Act had not done much to change people's daily lives. There was nothing mandatory, or even promotive, about the law. People were free to totally ignore it if they chose to do so. Nor did the Act or its companions do much by way of solving the old problem of nonuniformity. The distribution of metric standards to the States and the legalization of the use of the system had the potential for creating just the opposite effect, in fact, by officially sanctioning a second approved measurement system. And Congress' responsibility "to fix the standards" had not been discharged by passing this Act. In fact, no mention was even made of this Constitutional provision except to acknowledge its existence.

Another reason why the metric question was revived a short time later was that weights and measures reform had become an "institutionalized" proposition. The National Academy of Sciences' committee on the subject was made permanent in 1866, and the House Committee on Coinage, Weights, and Measures had been created as a standing committee. As the laws of 1866 left plenty of work still to be done by these and other bodies, it was only natural that they should, at some later date, wish to complete this "great reform." The 1866 champions of the metric system had set lofty goals and had made it clear that the actions proposed at that time were being offered only as temporary expedients.

Another factor in the persistence of the subject was the continued international growth of the metric system and the unceasing efforts of British metric advocates to secure compulsory adoption. Although over the next few years Great Britain first took steps to limit the use of the system and then reinstated it to full permissive status, that nation adhered officially to its ancestral standards until the 20th century. This gave rise to some hard fought metric "campaigns" in Britain that served as a stimulus and as models for groups in the U.S. who also wished to pursue the matter.

In short, the 1866 Act had not settled anything. It had, however, opened the door to further inquiry concerning the necessity and desirability of recognizing the metric system as the sole system of weights and measures in the U.S., at least for legal and governmental purposes.

When these inquiries took place, they revealed what the long-term effects of legalizing the metric system had been. In the first place, any sense of urgency for metric adoption which might have been generated by proponents of the system had been nullified by the system's legalization. In addition, the opponents of metric reform had been provided with what was perhaps their most effective argument, namely, that anyone who found it to his benefit to use the system might do so. Therefore, no legal reason existed to force its further use. The impracticability of unilateral action by anyone wishing to use the system when his competitors did not was a counter-argument which fell on deaf ears.

The Act did pave the way for a significant program of education on the subject, and a great deal of literature began to appear explaining the system and making available tables of English-metric equivalents. The accompanying resolutions that were passed also put higher quality standards in the hands of State governments. This practice has been repeated from time-to-time since 1866, and all of the standards distributed since then have been metric ones. A final benefit of the Act was that it allowed the U.S., in the 1870's, to participate freely in important international negotiations concerning weights and measures on an approximately equal footing with other nations. With scientific endeavors in this nation rapidly becoming a major source of international prestige and with a technological revolution about to burst forth, American science would need the most advanced standards obtainable and only those consistent and compatible with other nation's standards would serve the purpose. Securing Congressional approval for a general changeover to the metric system, however, was an entirely different matter from such considerations as these.

The first phase of metric investigation in the U.S. had ended. The ultimate goal of general adoption had been established and those actions had been taken which were thought to be reasonable first steps toward its eventual accomplishment. The general tone of the arguments in favor of the system had also been set. Some were borrowed from John Quincy Adams, while others had been newly-minted. It was felt that the action of foreign governments, especially Great Britain, had satisfied Adams' conditions and created the proper climate for U.S. action to achieve uniformity; that, compared to the English system of measurement, the metric system was simple to learn, easy to use, and precise in its nomenclature; and that the difficulties in achieving popular acceptance of the new names and values could be easily overcome—it was simply a matter of time and proper influence through the educational process. It was in connection with this last-mentioned aspect of the question—popular acceptance—that the greatest problems were soon to arise.

IV. A PINT'S A POUND THE WORLD AROUND? (1866-1890)

Because the Act of 1866 had not made the metric system mandatory upon the people of the United States, a great deal of missionary work remained to be done if the objectives set by the Committee on Coinage, Weights, and Measures were to be accomplished. Committee Chairman Kasson initiated just such a process less than a month after the Act was signed into law when he addressed an assemblage of educators in New York State. In urging upon this group strenuous efforts to educate "the rising generation" to the attributes of the metric system, he laid down the principal theme for the labors that were to follow.

Kasson's call to action was soon taken up by like-minded people and before long a full-fledged promotional campaign in favor of metric usage had been established. This in turn generated the first American counter-movement in opposition to its adoption. The resulting interest groups were active in publicly proclaiming their respective causes and were able to generate enough interest to pay for the issuance of an abundant supply of published material. The appeals used in these publications covered a wide range of argumentative postures, from calm and rational explanations of the groups' beliefs, all the way to impassioned chauvinism, occult interpretations of ancient metrology, and even invocations against "the awful French metric system" on religious grounds. To supplement the societies' written doctrines, regular meetings were held, various items were offered for sale, petitions memorializing Congress were circulated, and exhibitions were prepared for appropriate gatherings. Even though the three interest groups of this era were short-lived, they were zealous in the pursuit of their goals while they existed.

One of John Quincy Adams' long-postponed recommendations was also implemented during this period when an international treaty on weights and measures, the "Treaty of the Meter," was negotiated in 1875. Although the deliberations leading to this agreement were not exactly what Adams had in mind in 1821 (their sole purpose was to improve the metric system and its standards, and Great Britain did not ratify the treaty for several years) the end results of this collaboration, multinational agreements on weights and measures, were essentially the same as those sought by Adams. Great Britain did enact sweeping changes in its own weights and measures laws in 1878, but the metric treaty had marked a turning point in the international standing of the English customary system—it could no longer be advanced as the strongest contender to become *the* universal measurement system. From that point forward the English system was to be, in fact, a roadblock to the achievement of that ultimate goal.

Other noteworthy aspects of this era in the history of the metric system in the U.S. included the appearance of a popular literature devoted to it (other than that published by interest groups), a change in the forum in which the issue was debated, and the continuance of the close relationship between weights and measures questions and such other subjects as international coinage. On the publications front, school textbooks explaining the metric system and containing compilations of tables showing metric-English value equivalents became popular items. Newspapers, too, were willing to give attention to activities concerning the metric system as a matter of public interest. This broader exposure quite naturally led to an expanded forum for metric debate. Whereas earlier investigations and discussions had been confined mostly to governmental bodies and scientific circles, the topic was now placed before the general public on the lecture circuit and in lyceum courses.

All of these developments, taken together, meant that the question of metric adoption was becoming less and less an issue to be resolved on the basis of the system's intrinsic merits and advantages to science. Instead, it was becoming irrevocably linked to the social, economic, and political moods of the United States. The effect of this shift on the final outcome of legislative proposals cannot, of course, be measured in an absolute way, but the effect on the arguments used and on the way in which the question was debated can be seen with irrefutable clarity.

A. THE POLARIZATION PROCESS BEGINS

The controversy over the metric system during this period began in innocent-enough fashion—with the routine appointment of a "blue ribbon" investigative panel of university professors in response to Congressman Kasson's 1866 address. As a result of this survey, earnest opposition arose and things began to go sour for those favoring the introduction of the system in this country. Ironically, the protagonists in this first public debate on the metric question were both educators and were both associated with the same institution—Columbia College (now Columbia University) in New York City.

1. THE DAVIES-BARNARD SCHISM

At a meeting of the University Convocation of the State of New York, at Albany, on August 8, 1866, Representative Kasson noted the actions recently taken by the Congress to authorize the use of the metric system. According to one contemporary account:

> "The aim and hope of Mr. Kasson had been that he might enlist the large body of enlightened educators forming the University Convocation, in an active effort to advance the cause of metrological reform in our country, by diffusing among the people information in regard to the Metric System; by pointing out the merits of this system; and by meeting the objections with which the proposition to naturalize it here . . . is sure to be encountered [1]."

Accordingly, a committee was appointed, under the chairmanship of Professor Charles Davies of Columbia, to study the situation and report back at a future Convocation. Later accounts of this committee's establishment make it clear that most members of the Convocation, including Frederick A. P. Barnard, the President of Columbia, felt that the committee's findings were to be a foregone conclusion in favor of introducing the metric system into general use. But the committee took the opposite tack, tendered an unfavorable report, and thereby planted the seeds of America's first two organized pro-metric associations.

There is very little doubt that Davies' report, submitted in partial form in 1869 and published in full in 1871 [2], was mostly a reflection of his own views on the subject and not the result of unanimous agreement by the three colleagues who served on the committee with him at various times. Two earlier discussions seem to have influenced Davies a great deal in arriving at his conclusions, as they were appended to his report in full. These were John Quincy Adams' inquiry and a lecture that had been given by Sir John Herschel, an eminent British astronomer and an opponent of metric adoption in that country. Davies made no attempt to present the proposition in an unbiased light. Unlike Adams, Professor Davies immediately launched into a dissertation of his objections to the introduction of the metric system without devoting extensive consideration to the merits of the system and the possible advantages to be secured by its adoption. His opposition was based on five factors.

(1) The basic unit of the system, the meter, he considered to be inherently defective. To begin with the meter was not even what it purported to be, i.e., the ten-millionth part of the specified meridian, because later and more sophisticated measurements of the earth's surface had shown that the original French measurements were in error. Davies also felt that the meter was too large a base unit because "it is not easy to give a young and uninstructed mind a distinct apprehension of it; and . . . there are many things to be measured, in the common affairs of life, less than the meter, and these must all be expressed in fractions of that unit [3]." The "foot," as derived from the

British yard determined by pendulum vibrations, was a much more convenient basis for measuring length, he postulated.

(2) The decimal multiples and subdivisions, while being far superior for the purpose of calculation, were not, in Davies' opinion, the ones best suited for use in practical applications. His reasons for believing this are somewhat vague, as can be seen in the following extract from the report:

> "[F]or sensible objects, which are daily measured and handled, the French themselves have departed from [decimal usage] by introducing the half and the double, for most of the units . . .
> The *fractional units,* one-half, one-third, one-fourth, one-fifth, etc., must each and all be clearly apprehended before the mind can grasp, as a crystallized idea, the fractional unit one-tenth. Hence, no system of instruction can dispense with the divisions of the unit into any number of equal parts, nor can positive legislation affect it [4]."

Immediately following this passage, however, Davies extolled the virtues of our decimal coinage system, terming its adoption a "fortunate circumstance." Thus it appears that this objection was occasioned by the fear of certain unspecified practical problems rather than by a general dislike of the principal of a decimal system.

(3) The metric system's nomenclature, while perhaps suitable for scholars, would not be easy for school children to comprehend, Davies believed, because: "A child, knowing nothing of the Greek and Latin, would find greater difficulty in distinguishing between deca-metre and deci-metre, between hecto-metre and centi-metre, than he would if the things were called by entirely different names [5]." "Can we abandon, as a mere question of language, these short, sharp Saxon words [i.e., inch, foot, peck, ton, etc.], for their equivalents expressed in a foreign language [6]?" By advancing this argument Davies had injected an entirely new consideration into the debate over the metric system, namely an objection based merely on the system's *foreign* origins. This aspect of the debate was to be amplified manyfold in later years.

(4) Professor Davies also listed several things that he considered to be significant barriers to the *popular* acceptance of the metric system in the U.S. In the first place, he stated that if the system were introduced it would be necessary to exclude all other systems. If this were to happen, he prophesied:

> "The conflict will be fierce in this country, where the people are freer and less habituated to blind obedience to imperial edicts . . . nor will the fact, that the system comes from a foreign country, whose language and institutions are alike unknown to us, be without its influence [7]."

He also felt that another serious impediment to its introduction would be man's basic reluctance to cast aside old and familiar things in exchange for something unknown and untested. He termed this phenomenon "a law of the human mind . . . a species of intellectual inertia." Finally, Davies claimed that it would be shunned by the people because, unlike the customary system, metric units were not derived from parts of the human body and would therefore be meaningless to the public at large. The customary system "having such an origin was more likely to meet the wants of a people than one made amid the turbulence of a revolution by a committee of learned professors [8]," Davies concluded.

(5) The remaining objections to the adoption of the system that were advanced by Davies concerned the consequences of changing, and his strongest language was reserved for this particular set of assertions:

"1. It would strike out from the English language every word and phrase and sentence used in connection with our present units of weights and measures, and would impose the necessity of learning a new language for the one now in use:
2. It would blot out from the knowledge of the nation all apprehensions of distance, and area, and volume, acquired through the present units, and would render necessary the acquirement of similar knowledge by less convenient units, having different relations to each other, and expressed in a new and unknown language:
3. It would extinguish all knowledge of money values, now so familiar to the entire population in their daily purchases, and sales, and barters, for those values are all adjusted with reference to the units of weights and measures: and
4. It would change the records of our entire landed property, requiring them all to be translated into a new and foreign language [9]."

For these reasons, said Professor Davies, his committee could not recommend the metric system as an acceptable substitute for the existing system unless some provision could be made for retaining the "foot" as the basic length unit. Instead, seven resolutions were submitted for consideration by the Convocation, all designed to delay any action to adopt the metric system "without a very full and careful examination of all its bearings and all its consequence." These resolutions were approved, and the report was published and given wide circulation.

Although Davies investigation cannot be called a *tour de force*, for it is generally lacking in a firm foundation for most of the contentions advanced, even resorting to exaggerated statements in several cases, the extent of its influence was still noteworthy. In several respects it was the first of its kind and was an excellent barometer of things to come. In the first place the Davies' committee was the first one to give extensive consideration to the question from an educational point of view. It was also one of the very few educationally-minded groups ever to return unfavorable recommendations with respect to the metric system. Their report was the first one of any consequence to clothe social, political and economic arguments on the subject in a scientific garb in order to give credence to otherwise unsupported assertions. It also raised several brand new objections, including the foreign origins and features of the system, the fear of disturbing ingrained and well-known commercial relationships—such as the price of a commodity per unit of weight or volume—and the argument that all land surveys and deeds would be voided by adopting the metric system. Irrespective of the veracity of Davies' (and his committee's) contentions, the report illustrated the kinds of considerations that were to be brought more and more to the public's attention. In fact, these arguments seem to have been designed with just such an audience in mind.

The reaction to Davies' report from those favoring the introduction of the system was swift. President Barnard of Columbia took particular exception to the document, first in an oral address to a session of the Convocation and later in published form [10]. He was concerned not only with the unfounded objections to the use of the metric system, he said, but also with the impression that might be left by Davies with respect to Columbia College's position on this issue:

> "The Trustees and Faculty of the College with which the chairman of the Committee held formerly an official, and holds still an honorary connection,[1] have for some years been upon the record as advocates of legislation by the Congress of the United States, favorable to the unification of the Money, Weights and Measures of the world . . . . To them it appeared that the publication of a report prepared by a gentleman in nominal connection with them, maintaining an opposite opinion, was likely to produce an erroneous impression in the public mind in regard to their own position [11]."

Frederick Augustus Porter Barnard was one of the most notable luminaries ever to be intimately involved with the cause of metric advancement in the U.S. He is best known for his able leadership of Columbia from 1864 to 1868, and especially for his diligent advocacy of higher education for women. His efforts in this area resulted in the establishment of Barnard College for women at Columbia 6 months after his death in 1889 [12]. Born in 1809 and educated at Yale in the sciences, Barnard rose to become president of the University of Mississippi, president of the American Association for the Advancement of Science, director of printing and lithography in the United States Coast Survey (under Bache), and a charter member of the National Academy of Sciences. Two of Barnard's other accomplishments bear directly upon the history of the metric system and will be noted later in this chapter. His background and personality, as described in the *Dictionary of American Biography*, help to explain his interest in the introduction of the system into the U.S.:

> "He was, by nature and training, both a conservative and a progressive, but rather a progressive than a conservative. Having as his specialty mathematics and the allied sciences, he was yet a scholar in Latin and Greek, and knew, in a general way, several modern languages . . . . He was avaracious of new ideas, both to create and to acquire, to assimilate and to propagate. His spirit was missionary. Born with an instinct for persistent faithful-

[1] Davies was Professor Emeritus of the Higher Mathematics at Columbia.

ness, he persevered in the teeth, at times, of strong opposition against his measures [13]."

Addressing the University Convocation, in the teeth of opposition, he first noted the progress recently made with respect to the international metrological reform movement, particularly dwelling upon the recent additions to the list of nations having adopted the metric system. In the second part of his speech he presented a systematic refutation of the many exceptions to the metric system that had been raised by Davies in his recent treatise. "I cannot pass so lightly by," he said, "the objections which have been urged against the system, and of which, in my view, the importance has been, in most instances, exaggerated beyond all reason; since . . . . the high authority of this learned convocation has been made liable to be popularly regarded as attesting their gravity [14]."

Concerning the contention that the base unit, the meter, was too large, Barnard asked "too large for what?" He compared the size of the yard to that of the meter, noting that if a one-meter rule were too large to be convenient, the yard was no less so, being only 3 inches shorter. He also took exception to Davies' assertion that the foot had been established as the base unit of the English system, observing that the official English standard of length had always been the yard.

As to the difficulty of decimal division, Barnard found such fears to be imaginary, especially in comparison to the difficulty of repeated division by 12. No objection ought to be made to the use of decimals in education either: "[H]owever grave this business of [calculating by] ten may be, I suppose that our children must sometime or other know something about decimal arithmetic; and they will have to know something about it whether they learn the metric system or not . . . . The question is not whether we shall teach the metric system to babes, but whether we shall teach it along with the arithmetic . . . . which boys must learn at any rate [15]." Dr. Barnard could see no harm in permitting simple binary subdivision (halves, quarters, eighths, etc.) for practical purposes if the people found this to be more convenient, but, he felt, this alone was not sufficient reason to discard altogether the decimal principle and its attendant advantages. Davies' final objection to the decimal system—the fact that attempts to apply the principle to the division of the circle had failed to gain acceptance—Barnard answered with logic and insight:

"Those who use this argument ought to remember that the Arabic numerals, the symbols of algebra, and the division of the circle, are three things (and the only three things, I believe), which were the same for all civilized mankind when the metric system was created. To change the law of circular division was to introduce diversity where uniformity prevailed before; and also to destroy the usefulness of a vast scientific literature which had been founded on the sexagesimal division [16]."

To Davies' contention (and those of Adams and Herschel before him) that length units should be representations of parts of the human body, Barnard responded by citing examples of the arbitrariness and instability of standards based on such measures. Choosing the foot by way of example, he recalled the diversity of values given to it in various countries. In the Italian provinces, he observed, values for the old customary foot had ranged from 11.62 to 23.22 English inches; in pre-metric France provincial standards for the foot had been anywhere between 9.76 and 14.05 inches; and similar situations had prevailed all across Europe. By contrast, the metric units and standards had established the foundation for unprecedented uniformity from one country to the next. Besides, the subdivisions of the meter were just as adaptable for the purposes of practical approximations in everyday measurements as the customary units were, the difference between 30 centimeters and a foot being less than two-tenths of an inch.

With respect to the assertion that the result of metric adoption would be a total displacement of the customary system, Barnard replied:

> "I hardly know what to say about it; so that I am not sure that the truest wisdom in me would not be to let it alone altogether. It is the undeniable truth, that, *if we give up our present measures we shall cease to have them any longer.* . . . This is evidently a serious business. It reminds us of the sad case of the lad who, having eaten his cake, desires to have it again [17]."

But Barnard did not accept the proposition that introducing the metric system would invalidate land titles, for no legislation concerning the system could be made retroactive under the provisions of the Constitution. Instead, these changes would be made gradually as property changed hands and new surveys were made.

His final rebuttal was directed at Davies' claims that the selection of the French meridian as the basis for the standard and the admitted discrepancy between the theoretical and the actual meter had destroyed the perfection of the metric system. On the matter of France having chosen the Dunkirk-Barcelona meridian, Dr. Barnard said:

> "If . . . a tradesman, suspecting his meter to be in error, could adjust it by simply stepping out of his door and applying it to the earth's meridian, there might be some reason for complaint on the part of those, and they would be the majority of mankind, whose distance from the standard would deprive them of this facility. This not being the case, no practical disadvantage arises out of the inequality of the meridians, and it is only the simplicity of the original conception that suffers [18]."

The fact that the meter was not exactly the ten-millionth part of the meridian did not strike him as being a reasonable objection at all. If it had turned out that way, Barnard contended, it would have been nothing less than a miracle considering the existing state of geodesy in 1792, when the survey was begun. His advocacy of the meter had nothing to do with its actual relationship to the circumference of the earth, he professed, but, rather, was based on the fact that "it is the actual base of an admirable system of weights and measures already in use among one hundred and sixty millions of people, rapidly growing in favor among those who have not yet adopted it, and destined in my belief to be sooner or later the system of all the world [19]."

But Barnard had no desire to see the metric system put into effect without adequate preparation for the change:

> "I do not expect that this system will make its way to the world against the will of the people in the world. I do not expect that our people, and I do not desire that any people, shall be coerced into receiving it by the force of 'imperial edicts' or by the terror of bayonets. What I do expect is that they will sooner or later welcome it as one of the greatest social blessings . . . . This cannot take place, of course, until the people are thoroughly informed. There are influences, therefore, which are now only beginning to operate, which must first have their full course before the results I anticipate will make themselves manifest [20]."

Accordingly, he outlined a five point program of action for properly introducing the metric system to the people of the United States. Dr. Barnard's plan called for:

(1) Teaching the metric system in the schools so as to educate the young to a thorough understanding of the system and a familiarity with its practical applications;
(2) Putting the system into use in the custom-houses and making it the basis on which tariffs were to be levied;
(3) Adopting the metric weights and measures for public surveys, such as the coast survey;
(4) Requiring military and naval establishments to use the system; and
(5) Conducting all post office business in metric units [21].

These recommendations, set forth comprehensively in this document for the first time, were to become the principal points of contention in the metric debate for 40 years, and most of the legislative proposals advanced during that time were aimed at implementing one or more of these suggestions. The underlying strategy for them was clear and simple. They were based on the sincere belief that practical experience in applying the metric system, no matter how limited at first, would inevitably convince the people that a general changeover would be feasible and desirable. As the institutions most widely connected to the people as a whole were the schools and the Federal Government, it was only natural that they were chosen to be the vehicles through which such an initial introduction should be made.

And so, with this first trading of blows in public, the notion came to an end that affairs involving weights and measures were best left to those having a first-hand knowledge of their intricacies. The debate in a new forum would be far less restrained than it had been previously, and this development gave opponents the upper hand. One reason for this was that the entire concept upon which the metric system had been founded was arrived at through a logical process. The system was designed to appeal to seekers of order and perfection. But the question of metric adoption was not to be discussed in a

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rational, orderly fashion, thereby nullifying the system's strongest attributes. Another reason the opponents were able to seize the advantage is that nothing at all had to happen in order for them to carry the day. The burden of proof lay with those who were asking for a change, and as long as the opposition could generate doubt and fear no great popular demand for the change was likely to arise. Considering the pervasive use of the customary weights and measures, and assuming the existence of a strong tendency to take their importance for granted, creating such doubt could not have been too difficult. As a result, those who advocated adoption of the metric system had *two* tasks to accomplish: they first had to rebut the arguments of the opposition and then convince others that what they were proposing was desirable. The Davies-Barnard debate was only the first of many encounters along these lines, but, by drawing so clearly the lines of the dispute, a general pattern was established for others to follow.

2. CONCURRENT DEVELOPMENTS

Between 1866 and 1871, when the Davies-Barnard controversy was still in the formative stages, other events were occurring that eventually intensified the belief that metrological reform on an international scale was urgently needed. To begin with, it will be recalled that, in its 1866 legislative recommendations, the House Committee on Coinage, Weights, and Measures had included a resolution providing for American participation in uniform coinage negotiations at the Paris international exposition of 1867. At this exposition an informal convention of official delegates was held and resolutions were adopted that proclaimed the superiority of the metric system and urged its widespread acceptance in order to secure the benefits of uniformity [22]. Teaching the metric system in public schools was specifically recommended along with actions promoting its use in scientific publications, public statistics, postal and customs work, and other functions of a governmental nature [23]. As one of the American Commissioners to the Paris exposition was F. A. P. Barnard [24], it is logical to assume that his 1872 suggestions on behalf of the metric system were strongly influenced by this convention's actions and proceedings.

In the same year the International Geodetic Association, made up of delegates from major European nations, met at Berlin and agreed to the need for new and common standards to make all European geodetic work comparable [25]. The Association decided that their purposes would be served best by adherence to a uniform decimal system and recommended the adoption of the metric system. The convention also called upon participating nations to provide for the construction of a new European prototype meter, differing as little as possible from the French meter and compatible with it to the highest degree of accuracy obtainable [26]. To insure full international participation, construction of the new standard was to be entrusted to an international commission and the desirability of establishing a permanent international weights and measures organization was to be considered [27]. The consequences of the Geodetic Association's decisions will be fully discussed in the next section of this Chapter.

The next year, 1868, the North German Confederation decided to make use of the metric system mandatory after January 1, 1872 [28]. This decision was reaffirmed in 1871 after the further consolidation of the German states under Emperor William I [29]. The German action was important to the metric cause, especially in later years when her industrial might was to become a factor in world affairs, because Germany had been the last major European "holdout," with the exception of Russia and, of course, Great Britain. The German changeover would require many years to accomplish, but there was now almost total uniformity of weights and measures, at least for legal and commercial purposes, on the European continent.

On the British front, metric advocates proposed a bill in 1868 making use of the system compulsory, but after a second reading it was dropped [30]. In the meantime, the whole subject of English weights and measures was being studied by a Royal Standards Commission under the chairmanship of Sir G. B. Airy, the astronomer-royal. The Commission's second report, dated April 3, 1869, was given over solely to the question of metric adoption [31]. It was the opinion of this commission that Britain was not yet ready to accept the metric system because its superiority over the customary system had not yet been proven [32]. It was recommended that its use again be made permissible, but this suggestion was ignored.

In the meantime, a few concurrent actions of interest were taking place in the United States. At its annual meeting in January, 1867, the National Academy of Sciences again demonstrated its interest in the subject. Noting the actions recently taken by Congress, the Academy passed four resolutions favoring further efforts to make use of the metric system a practical reality. Three of these resolutions centered around the principle "of educating the community and especially the youth of the country" in the metric system by adding it to school curriculums [33]. The fourth declared it to be "highly desirable that the discretionary power granted by Congress to the Postmaster General to use the metrical weights in the post offices . . . [be implemented] at the earliest convenient day [34]."

In the U.S. Congress the subject lay dormant until 1870, probably because there was no apparent need for further legislation in view of the productive output of the Committee on Coinage, Weights, and Measures in 1866. In 1870, however, during the second session of the 41st Congress, several metric bills were introduced and referred to the Committee, now under the chairmanship of a Pennsylvanian named William Kelly [35]. In all, four bills were proposed at this time—two dealing directly with the metric system itself, and two tangentially related through international coinage system proposals. The two metric bills were both introduced on February 3, 1870 by Representative Allison. *H.R. 1087* was a bill "to enable persons who use the metric weights and measures to transact business therein at the public offices of the United States." Its companion, *H.R. 1088*, was more specific, providing that: "on and after the first day of April, eighteen hundred and seventy, the entries of goods at the custom-house, and lists and returns for assessment of internal revenue shall be made in [metric units]. . . instead of in the weights and measures now in use . . . And in all acts and parts of acts relating to rates of postage, one ounce shall be held to mean 30 grams." No report on either of these two proposals was issued by the Committee on Coinage, Weights, and Measures.

The closely-related coinage proposals—one "to promote the establishment of an international metrical system of coinage" and the other to determine the value and weight of gold coins in the U.S., Britain and France—were combined in a single bill and made the subject of a report to the House, upon which no action was taken. The purpose of these bills was to put the American decimalized monetary system before an international committee as the possible basis of an internationally-uniform coinage system based on the metric system of weights. When nothing was done about this recommendation, the Committee dropped the subject of weights and measures for several years. Between 1871 and 1873 it was preoccupied with revising the laws relating to counterfeiting and the statutes governing the operations and procedures of the mints and assay offices. After that, it was practically inactive until 1877. The only other event worthy of note that occurred in Congress between 1866 and 1876 was the passage of a second resolution in 1872 authorizing the use of metric weights in the Post Office Department. This was not compulsory upon the Department, however, and was not implemented because: (1) no appropriations were made to provide funds for changing over the scales; and (2) Department officials apparently did not favor the change.

In other areas of Government concern, however, significant developments were brewing that eventually would cement the preferred international standing of the metric system.

B. THE "TREATY OF THE METER"

As a result of the 1867 decision by the International Geodetic Association to seek a reformulation of metric standards, the St. Petersburg Academy of Sciences suggested to the Paris Academy of Sciences, in 1869, some initial steps toward the establishment of an improved, international metric system [36]. According to one account, this proposition was not enthusiastically received in France, where the metric standards were considered by French men of science to be untouchable artifacts not to be meddled with by foreigners [37]. Other members of the Paris Academy, however, were not so parochial in their outlook and were willing to concede the desirability and practicability of constructing new standards provided that they were not too far removed from the existing ones. Accordingly, Emperor Napoleon III, acting on the basis of his government's recommendations, issued invitations through diplomatic channels to attend a convention to be held in Paris at which the fabrication of a new prototype meter and kilogram would be discussed and arrangements made to supply each of the participating nations with a duplicate set of the new standards.

Twenty-four nations accepted invitations and their delegates convened at Paris in August, 1870, forming themselves into an International Commission. Before much could be accomplished the Franco-Prussian war began and the session had to be called off. In spite of the short duration of the conference the delegates had managed to lay the groundwork for future discussions and had agreed in principle to the idea of a neutral, international repository for the new standards.

When peace had been restored, the French Government recalled the Commission. When they again met at Paris, in September of 1872, 30 states were represented by 51 commissioners, including many of the world's foremost scientists [38]. The American commissioners were Mr. J. E. Hilgard of the Coast Survey and Joseph Henry, president of the National Academy of Sciences and chairman of its 1866 committee on weights, measures, and coinage [39]. About 40 resolutions were passed dealing with the construction of new prototypes, and the creation of an international bureau of weights and measures was recommended to the participating governments [40]. A permanent committee was also appointed to carry out the Commission's recommendations and to take charge of the work involved in manufacturing the new standards [41]. By 1875 the planning and design work on the new standards had progressed so well that the permanent committee requested the French Government to convene a diplomatic conference to discuss ways and means for verifying the new standards and insuring their permanent preservation.

In response to this request, official representatives of 19 nations, the United States included,[2] met at Paris beginning in March, 1875 [42]. On May 20, 17 of the 19 countries signed the *Convention du Metre* ("Treaty of the Meter") providing for the establishment and maintenance of a permanent International Bureau of Weights and Measures to be situated near Paris and to be under the control of an international committee of 14 members from different countries. The convention was ratified by President Rutherford B. Hayes on September 27, 1878, the U.S. Senate having approved the measure [43].

The prime mission given to the International Bureau was to construct and verify the new metric standards. Additional work was to include: (1) the custody and preservation of the international prototypes and associated instruments, when completed; (2) a periodic comparison of the several national standards with the international prototypes; and (3) the comparison of metric standards with different standards of other countries [44]. The cost of doing this work was to be met through contributions by the participating governments, the size of the payments depending upon population and the extent to which the metric system was in use in each country [45]. The Bureau was to be responsible to a General Conference on Weights and Measures, meeting every 6 years to decide on questions of importance, and to the permanent International Committee of Weights and Measures, meeting every 2 years [46]. This general plan of organization, with the Committee being responsible for insuring that the Bureau implements the decisions of the Conference, has continued to the present day.

As the French Government desired to have the International Bureau established close to Paris, the birthplace of the metric system, they agreed to

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[2] Represented by Elihu Benjamin Washburne, Envoy Extraordinary and U.S. Minister Plenipontentiary to Paris.

provide the site and facilities for it. The Pavillon de Breteuil, a royal estate near Sèvres in the Parc de Saint Cloud, was made available and declared to be neutral territory for this purpose. The necessary repairs to the buildings were made and facilities to house the scientific apparatus were completed in 1878 [47]. An Italian physicist, Gilberto Govi, was elected as the Bureau's first director [48], although the position had been offered previously to Mr. Hilgard, who had declined to accept it [49].

The actual work of constructing the new standards was begun in 1877 and was not completed until 1889. This was mainly due to the difficulties involved in obtaining the necessary quantities of extremely high-purity platinum-iridium alloy and in casting it into meter "bars" of an unusual X-shape, as specified in the design [50]. When the work was completed, the First General Conference on Weights and Measures was convened, the ultimate national prototype standards were selected from among all those manufactured, and arrangements were made for distributing the identical copies which remained to the member nations. Whereas the international prototypes had been selected from among the 31 meters and 40 kilograms on the basis of their close conformity to the previous standards, the ones distributed to the various countries were determined by drawing lots. The United States drew meters numbered 21 and 27, and kilograms numbered 4 and 20 [51].

The American prototypes were packaged for shipment in Paris and sealed by Benjamin Apthorp Gould, U.S. delegate to the International Conference. One of each was brought to this country by Mr. George Davidson, an Assistant in the Coast and Geodetic Survey [52]. On January 2, 1890, the seals were broken at the White House and the standards were certified and accepted by President Benjamin Harrison. They were then placed in the vault of the Treasury Department's Office of Weights and Measures to await the receipt of the other two. These were received in July. Three years later, on April 5, 1893, the same standards were declared to be the nation's "fundamental standards" of length and mass by an administrative action of the Superintendent of Weights and Measures, sanctioned by the Secretary of the Treasury [53]. More will be said about the importance of this action in subsequent chapters.

Through this collaborative effort the metric system had been made the official international system of weights and measures, and it was recognized as such by most of the major commercial and scientific nations in the Western Hemisphere. Its future was never in doubt from this point forward, only the extent to which it would someday become universal.

C. AMERICAN METRIC ADVOCATES ORGANIZE

With international metrological proceedings well under way in the early 1870's and with the lines of battle having been formed for a metric debate in this country, the time had come for a full-blown campaign to begin. In all, three organizations were established—two favorable to the proposed reform and the other opposed. The advocates were the first to organize, beginning with the American Metrological Society in 1873. Its goals were somewhat broader than just securing adoption of the metric system, but the activities of the American Metric Bureau, established in 1876, were strictly limited to metric advocacy.

As organized opposition did not appear until the very end of the decade these two groups had things pretty much their own way for several years. While they were not able to parlay this advantage into securing formal adoption of the metric system by legislation, this was not their main goal. They were, rather, interested in seeing the metric system gradually make its own way by virtue of being endorsed by the educational system. In this they were partially victorious, although they precluded themselves from showing truly outstanding progress along these lines by confining their operations geographically to the eastern seaboard States.

1. THE AMERICAN METROLOGICAL SOCIETY

The American Metrological Society was the creation of that devoted friend of the metric system, Frederick A. P. Barnard. Demonstrating the sincerity of the views he had previously presented to the University Convocation, he issued, on October 22, 1873, an invitation to colleagues who had expressed an interest in metrological reform to meet at Columbia College on December 30. Noting the progress made by European nations in adjusting their measurement systems to bring them into conformity with each other, Barnard deplored the lack of general interest in this process that had been shown by the English-speaking nations. He believed that this oversight would be rectified in part by forming an association "to take into consideration the various interesting questions connected with metrological reform, to spread information in regard to these among the people, and to concentrate effort towards the accomplishment of such practical measures of improvements as, upon full deliberation, it may seem judicious to attempt [54]." Barnard concluded his invitation by stating that it had been occasioned by the recent receipt of a letter, signed by Joseph Henry and other leading American scientists, asking him to take the initiative in establishing an appropriate organization for such purposes.

Twenty-three individuals responded to Barnard's call. The majority of these — 19 — were from academic institutions. The minutes of this first meeting show that among the gentlemen in attendance were Professor Charles Davies, the Honorable John A. Kasson, and Mr. J. E. Hilgard. Following the adoption of a provisional constitution, Barnard was elected President, Kasson (no longer the Chairman of the Committee on Coinage, Weights, and Measures) was selected as Vice President, and Hilgard was named a member of the Council, which was empowered to conduct the Society's business between meetings. Dues were set at $5.00 per year.

For the next few months the Society was engaged primarily in charting its own course, adopting a constitution and by-laws, and building up its membership. Although members were actively sought, it was never intended that the work of the group should have widespread public appeal. From the very beginning the Society was designed to be semiprofessional and semipolitical, with emphasis on the former rather than the latter. It was successful in attracting some of the most distinguished men in the country to the aid of its cause, however, and thus the Society compensated for its lack of numerical size with prominent names. Among its members were Hamilton Fish, Secretary of State under President Grant; John J. Knox, Controller of the Currency; Senator Sumner; a dozen Congressmen, including the current Chairman of the House Committee, Alexander Stephens of Georgia and former Chairman Kelly of Pennsylvania; Samuel B. Ruggles, ex-commissioner for international coinage matters; Charles S. Peirce, Bache's replacement as Superintendent of the Coast and Geodetic Survey; Major John Wesley Powell of the Smithsonian Institution (better known as the first white man to venture through the Grand Canyon by boat); five college presidents, including Barnard and John D. Runkle of the Massachusetts Institute of Technology; and many other well-known educators, scientists and engineers. The most outstanding single characteristic of the membership as a whole, aside from its common interest in the science of weights and measures, was its geographical concentration in the eastern States. Of the 171 members listed in 1880, 124, a full 73 percent, resided in the States of Massachusetts, Connecticut, New York, New Jersey, Pennsylvania and the District of Columbia. This may be contrasted with a total of 19 members (11%) residing west of the Mississippi River, most of these in the St. Louis, Missouri and Denver, Colorado areas. Even at its peak, then, the American Metrological Society was principally a group of eastern scientists and government officials and was in no sense a "grass roots" movement akin to the flowering Populist reform movement of the middle west and prairie states.

The constitution of the Society, adopted in 1874, made clear its aims without direct reference to the metric system as an object of attention. The stated purposes were threefold:

(1) To improve existing systems of weights, measures and moneys, and, to the greatest extent practicable, to bring them "into relations of simple commensurability with each other."

(2) To secure, among scientists and engineers, the universal adoption of common units of measure for use in presenting the results of their work. The Society was particularly interested in doing this in newer areas of scientific investigation "for which the ordinary systems of metrology do not provide." Specifically mentioned were divisions of the barometer and thermometer, combustion measurements and expressions of electro-dynamic current.

(3) To "secure as far as may be the acceptance of the system of decimal derivation" (obviously implying the metric system). It was stressed that this was to be done for ease of calculation and to conform to numerical notation, and did not mean that binary or other systems would have to be excluded if found preferable for practical purposes [55].

Even the methods by which these objectives were to be accomplished were spelled out in the Society's constitution. In this section the influence of Congressman Kasson may be seen clearly, for much of the language was lifted directly from his Committee's 1866 Report to the House of Representatives. In the main, the Society planned to prepare the people of the country "to act intelligently upon the important questions" by appealing to Congress, State legislatures, boards of education, institutions of higher learning, and educators in general. The Society would also seek assistance from boards of trade, chambers of commerce, engineering societies, industrial associations and, in particular, scientific bodies. Congress was to be further memorialized:

> "In favor of the enactment of laws requiring the use, in certain departments of the public service, of the metric system of weights and measures where such legislation may tend to relieve commerce of some of its burdens to facilitate international communication, to promote international jurisprudence, and to familiarize our own people with the benefits of that system of metrology with the least interference with their ordinary habits of thought, or daily business [56]."

Finally, the Society resolved to take its appeal directly to the people through the medium of the public press and through books and documents extolling the virtues of a universal measurement system.

These were ambitious plans—perhaps too much so for the resources available to the group. Because a great deal of the money received as dues or donations went to paying for the printing and distribution of the Society's *Proceedings* to its members, very little was left over for other purposes. A year-by-year record of the Society, as contained in the *Proceedings* (which were published only until 1888) shows that it built itself from more than 70 members at the end of its first year to nearly 200 members in 1881. There was a sharp drop-off in 1884, to about 90 members, which continued until only 57 were left in 1887. Likewise, the Society's treasury fluctuated a great deal, although the figures tend to be misleading because publications were only printed when a sufficient cash balance had been accumulated. Nevertheless, the Society's treasury balance was never more than $1,300, and the Society was actually in debt on several occasions. Even in the 1880's this amount was not sufficient to conduct any massive "lobby" effort on behalf of the metric system.

Throughout its history, the American Metrological Society employed predominantly low-key tactics to achieve its goals. Some pamphlets and public announcements aimed at promoting the introduction of the metric system were prepared, but they were intended to be educational, not inflammatory. While Barnard was at the helm (until his death in 1889), the Society was careful to preserve the scientific aspects of its character and only ventured into the forum of public debate on infrequent occasions. Above all, it tried to remain dignified, even in the face of some of the public insults it received in the mid-to-late 1880's. Quite possibly it held itself too aloof to be effective—meetings were held only twice each year, its legislative activities were mainly limited to circulating petitions to send to Congress, and a considerable portion of its deliberations were given over to metrological subjects other than the metric system. As a second pro-metric group was created by the Society in 1876 to fill in the gaps it left and to focus on metric questions, it seems reasonable to conclude that the Society as a whole was more interested in broader areas of concern, even to the detriment of its metric interests.

Among these other areas were questions of adopting a uniform international system of coinage and securing a system of standard time zones for the United States. Its efforts on behalf of the former reform were doomed to failure. Inevitably the Society and its committees became entangled in the bimetallism controversy dealing with the disparity between the market ratio of silver to gold and the fixed mint ratio for the same metals. Nor, apparently, were many major foreign governments vitally interested in securing coinage uniformity. With respect to the establishment of standard time zones, the Society, or at least one of its members, a Sanford Fleming of Canada, played an influential role. During the 1880's the question of how to divide the U.S. (and Canada) into reasonable time zones arose. Much discussion of the various alternatives was published by the Society, with Fleming being a major contributor. His plan was the one that was eventually adopted, principally through the good offices of the railroads (who had the biggest problems with respect to uniform time practices).

The interest invested in these problems did not mean that the American Metrological Society was silent or inactive on questions concerning weights and measures and the metric system. Far from it. In fact, one of the Society's earliest actions was the drawing up of an elaborate communication to Congress detailing the need for metrological reform and outlining the program of action it was urging, including:

(1) Adoption of the metric system as the official basis for assessing tariff duties;
(2) Restoration of the "vitality" of the 1866 metric postal provisions by passing a new law *requiring* the metric system to be used;
(3) Use of the metric values, along with corresponding English values, in government reports describing public works and in statistical and other documents issued by the executive branch; and
(4) Adjustment of the weights of U.S. gold coins so as to make them expressible in metric denominations [57].

In the same year, 1874, Barnard circulated another document that was very explicit as to the urgency of metric adoption and that was designed to secure the voluntary use of the system by professional men in their everyday work:

"It is clear that England, owing to her position in Europe, must very soon complete the process she has already begun of adopting this system.

The United States should not wait for England. The German, French and other foreign element here already exerts a great pressure in the direction of its general adoption. Moreover, having already, in our dollars, dimes, cents, and mills, the principle of the metric system in actual use before us . . . no serious difficulty will be encountered even with the most uneducated classes . . .

> Under our republican form of government, it is not to be expected that our national legislature will, in a matter so nearly touching the daily business and habits of every citizen, be in advance of the people themselves. Congress has made the metric system legal, and has power to make it compulsory; but this is a power which that body is not likely to exercise until a call for such action shall come up to its members from their constituents at home [58]."

Endorsing these sentiments were some of the most respected gentlemen of their day, including President Charles W. Eliot of Harvard, Oliver Wendell Holmes, Henry Wadsworth Longfellow, Charles Francis Adams, Major General Winfield S. Hancock, future Supreme Court Justice Samuel Blatchford, and no less than 26 congressmen and Senators representing 17 different States. With such a power base from which to operate, it is quite strange, indeed, that Dr. Barnard never succeeded in really launching a widespread metrological reform movement.

The Society's plan to invoke the aid and cooperation of other associations was carried out only spasmodically. On one notable occasion in 1875, however, when asked by the Boston Society of Civil Engineers to collaborate on a memorial to Congress asking them to fix a date after which the metric system should be the only legal system of weights and measures, the Metrological Society responded by passing a resolution to the effect that:

> "The time has not yet come when it is possible to fix a date for the compulsory adoption in all public and private transactions of a uniform system of weights and measures; . . .[therefore] present efforts should be directed toward the gradual adoption of the metric system by the Government for international purposes . . . and toward the instruction of the public in regard to the nature and advantages of the metric system [59]."

While this opinion may have represented a realistic view of the existing situation, the pompous phrases in which it was stated could not have instilled much enthusiasm in other groups for seeking cooperation from the Society.

In carrying out its planned program to encourage educational use of the metric system, the Society again resorted to circulating letters explaining their cause and the reasons for it. In late 1875 a circular was mailed to over 350 colleges urging them to make familiarity with the metric system a condition of admission. In 1876 this was followed up with a letter to secondary and lower-grade schools suggesting that:

(1) Every teacher should make himself thoroughly familiar with the metric system so as to be prepared both to use it and to "defend it against objectors."
(2) School children should either be supplied with or required to provide themselves with a ruler graduated in both metric and English dimensions.
(3) Every school should have a set of charts and models illustrating the metric units of length, weight and capacity [60].

The Society apparently reached the decision early in its life, however, that this phase of the work was too important to be left solely to its busy and limited membership, for an entirely separate interest group was formed under its auspices in 1876 in order to pursue the educational efforts more actively. When the metric issue was revived in Congress, beginning in 1877, this left the Society free to concentrate on that aspect of its activities. The role it chose to play in the legislative process was primarily that of being a catalyst, as will be seen in the next section.

Just as the American Metrological Society thrived under Barnard's personal leadership, so did it languish after his death in 1889. Although the organization continued to exist until about 1906, it ceased to be an influential spokesman for metrological reform. After the publication of its *Proceedings* ceased in 1888, the Society's main activities were the distribution of a few promotional pamphlets, the preparation of pro-metric briefs for consideration by the House Committee on Coinage, Weights, and Measures, and an occasional appearance at Congressional hearings by a representative of the Society. The Society had, in fact, begun to atrophy even before Barnard's death, as the following extract from the published minutes of the December, 1886 meeting shows:

"Dr. Barnard remarked that the little interest shown in the Society, as evidenced by the decreasing paying membership [in the last year the number had fallen from 89 to 68] and by the lack of proper material for printing, raised the question whether it would not be best to let the Society die.

Mr. [Melvil] Dewey said: 'I am thoroughly opposed to allowing this Society to die. It has done much excellent work in the past, and has much more to do in the future. When we consider what it has accomplished in forwarding the introduction of Standard Time, and in educating the general public to the advantages of better weights and measures, we shall not be willing for its career to stop, though we might wish that more members took an active interest. Our members are scattered through the country; they are nearly all specially busy men, and we must be content if most of them do no more than give their names and their annual fees to maintain a work in which they are interested. . . . A more active campaign in favor of the Metric System would waken new interest in many places. To all such efforts the public has responded promptly [61].' "

Neither the public nor the Society responded to this appeal, however, and the Society's effectiveness gradually waned until interest in it all but disappeared.

2. THE AMERICAN METRIC BUREAU

On July 28, 1876, the American Metric Bureau was organized in Boston [62]. Although the Bureau was established as an independent organization, it was an outgrowth of the American Metrological Society and was linked to that group in ways other than through their common interests. The most obvious of these is the fact that F. A. P. Barnard was the Bureau's President. The Metric Bureau was also partially financed by the Society, although its main source of support was membership participation.

Unlike the Society, the American Metric Bureau was not principally a scientific organization. Incorporated under the laws of the Commonwealth of Massachusetts as a "missionary society for educational purposes," it was the Bureau's desire to enlist educators and merchants in the drive to introduce the metric system into the U.S. Its aims were also more focused than those of the Society, being "to disseminate information concerning the Metric System; to urge its early adoption; and to bring about actual introductions wherever practicable," according to the constitution adopted in 1876.

The Bureau also differed from the Metrological Society in that Barnard did not take personal charge of its day-to-day affairs, its Boston location making this impossible. Rather, this task was left chiefly to the Secretary, Melvil Dewey, as well as to three vice-presidents, Prof. W. F. Bradbury, Prof. William Watson, and the Hon. Charles Francis Adams. Both Adams and Dewey are still remembered for their contributions to other fields of endeavor. Charles Francis Adams (1807-1886), was the son of John Quincy Adams and the grandson of John Adams. During the American Civil War he was minister to Great Britain, and had distinguished himself by keeping that nation out of the conflict [63]. Melvil Dewey (1851-1931) was, at the time, a young man whose fame as the inventor of the Dewey Decimal System of library classification was yet to come [64]. Dr. Barnard was apparently very impressed with Dewey's abilities, however, because he hired him to be Columbia College's head librarian before too many years had elapsed. As has already been indicated, Dewey continued his efforts on behalf of metric adoption after moving to Morningside Heights as a member of the American Metrological Society. The American Metric Bureau, however, did not survive the transplanting of its hardest worker and it began to decay shortly after Dewey's move (about 1881).

The officers of the Bureau were chosen by and from a board of 10 directors, who were elected by the membership at large. The board of directors met once each month, and regular meetings of the members were scheduled quarterly. All officers served without pay.

To attract as many supporters to the cause as possible, an unusual combination of membership arrangements was offered by the Bureau. To begin with, regular memberships were offered which entitled the individual to a free copy of each publication of the Bureau. There was no fixed fee for this class of membership. Rather, each person agreed to pay an assessment, not over $5.00 annually, that was to be fixed by the board.

For the more affluent, honorary memberships were made available for $25.00 and life memberships could be purchased for $50.00. Only 100 of the latter were to be offered by the Bureau, though, and none of the proceeds from the sale of life-membership certificates were to be used in running the Bureau's affairs. Instead, the life members would form their own separate corporation, elect a board of three trustees, and invest the revenue in purchasing and re-selling, at the lowest possible cost, the "articles needed for the teaching, introduction, or actual use" of the metric system. To further safeguard these funds, the Bureau's constitution also provided that "the life members shall not dissolve their organization, except by unanimous vote, till the Metric Weights and Measures are made our only legal system." Surprisingly, all of the life memberships had been given out by the end of the Bureau's first year of operation, and 100 "preferred" life memberships were offered at the same price in order to raise additional capital for the "Sinking Fund" from which the metric equipment was to be purchased. "Preferred" life memberships were, in reality, guaranteed loans paying 6 percent annual interest under the rules established by the trustees.

The Bureau also recognized that a good many less well-to-do individuals ("especially lady teachers in small villages and country districts where small salaries are paid") might be equally interested in the work. Because the size of the membership was of paramount importance to the Bureau, it offered associate memberships for only the cost of a subscription to *The Metric Bulletin*, its principal publication. As this amounted to only about $1.00 a year it was not prohibitive and high hopes were held out for the attainment of a large clientele group.

The size of the Bureau's membership was not reported on a regular basis, but a little more than a year after it was founded it claimed to have 400 members. Like most groups of this nature, it complained at the same time that "less than a fourth of the members . . . are doing most of the work [65]." Although no demands were made upon the member's time, each was "supposed to feel an added interest in the work that will lead him to do all he can to advance it." The Bureau was also more than willing to accept additional financial support from those sympathizers wishing to compensate for their inability to participate more actively in person, as it announced on several occasions. This was more of a fond wish than a realistic expectation, however.

The main activities of the American Metric Bureau, aside from the publication of the *Bulletin* containing metric information of general interest, were delivering pro-metric addresses to various groups, circulating published material and posting charts in prominent places, and selling actual metric scales and measures for use in the classroom and elsewhere. The last-mentioned program was by far the Bureau's most ambitious and expensive one, and the staunchest supporters were still trying to make a go of it as late as 1889, long after the organization as a whole had ceased functioning as an effective interest group. A catalog and price list of books, charts, and apparatus issued in that year includes entries such as the following:

"Chart No. 1.

Conceded by all to be a most useful appliance for teaching either children or the masses . . . Each part is engraved with great care from drawings made of exact size from government standards. This is the finest illustration of the system ever printed, and invaluable for schools and other public places. It requires eight printings, all measures being in natural colors. These charts were prepared at great expense, and are an ornament for any room. No more valuable service can be done the cause than hanging them in prominent places. Price, mounted on cloth, varnished, $2.00."

In all, 5 charts were offered, 4 textbooks, a variety of desk rulers, pocket rules, linen and steel tape measures, sets of capacity measures and metric weights, and even scales imported from France. Of particular importance to the Bureau were the specially-assembled school kits, representing an assortment of items, because: "The importance and necessity of teaching the metric system is conceded by all interested in education; the value of the actual weights and measures as object-lessons to be handled and used is equally apparent." Five different sets were available from the Metric Bureau, ranging in price from $6.00 to $25.00. The $15.00 set for example, consisted of 34 pieces, including two different charts, two wooden meter sticks and a paper replica; a four-fold 40-centimeter pocket rule; a 10 meter linen tape; a special, graduated wooden liter block and copper liter case; a set of capacity measures in tin; a "dekaliter"; a set of iron weights; a special school scale; and two textbooks.

But the wholesale distribution of illustrative metric equipment was not the only work done by the Bureau to promote its cause, as a report of its first year's activities indicates:

"During that year a central office, supplied with large collections of everything illustrating the international measures, has been kept open, and thousands of people have visited it, receiving explanations and answers to their inquiries. Some scores of branch offices have been established, where more or less illustrative material has been exhibited and explained. Several hundred addresses have been delivered, by or through the efforts of our members, throughout the country. Many hundreds of articles have been printed in the papers and magazines, through the influence of the Bureau. Over half a million pages of circulars, placards, etc., explaining or advocating the system, or in some way directly calculated to advance its introduction, have been distributed gratuitously and judiciously, reaching nearly every township in the United States. Numerous committees have waited upon branches or departments of the State and national government, and in nearly every case have accomplished something in the desired direction. Very many schools have been visited in the interest of the system, through the influence of the Bureau. At some time during the year, each of the eight thousand periodicals of the country has been reached, and some hundreds have promised cooperation in carrying forward the introduction . . . .[In addition,] there has been maintained a heavy correspondence, reaching every section of the country. Of the labor involved some idea may be had from the payments for postage, amounting in the twelve months to $294.20 [66]." [3]

[3] At a time when a first class letter required only a 1-cent stamp, this was a considerable volume, indeed.

In spite of the glowing account of services rendered, and the favorable prognostications for the success of the organization that went along with it, the American Metric Bureau was suffering from a serious and persistent problem—a shortage of funds. Month after month the *Bulletin* contained appeals for more monetary assistance:

November, 1876–"The committee desires to urge upon friends of the cause the necessity of pecuniary support. The expenses of the Bureau are very small indeed for the amount of work which it is doing, but the heavy correspondence, and Bulletins and circulars, all entail expenses."

March/April, 1877—"An increasing number of members and correspondents are remembering that the Bureau is not a business house, with goods to sell at a large profit, and so enclose stamps and often slight contributions where they cannot afford more liberal . . . . Gifts of any amount are most welcome . . . . although the society is accomplishing very much, the work is crippled and embarrassed for want of funds, and every one who wishes it to succeed should give something, however small, to the general treasury or to any special object desired."

November, 1877—"This great work has required, with the greatest economy, a considerable expenditure . . . . at the present time there is greater need of additional funds than ever before. There are opportunities for carrying forward the work, so well begun, that must not be allowed to pass unimproved."

March, 1878—"Most of our active members, knowing how much we accomplish with the money, will be willing to make some little sacrifice if necessary, in order that the work may not be crippled at this critical time, when early and complete success seems assured."

In order to keep up the membership's confidence that success was indeed within the Bureau's grasp, other articles were regularly included in the *Bulletin* that related how many metric adoptions were being made in this country on a voluntary basis. Extracts from newspaper and magazine articles favorable to the cause were also reprinted, and one whole issue contained recent proceedings of the American Metrological Society. Very little of the *Bulletin* was given over to Congressional or State legislative transactions, though, and exhortations to "write to your Congressman" were very rare.

As with the Metrological Society, the American Metric Bureau believed that creating a widespread popular demand was the surest road to victory. To them it appeared to be a simple matter of exposing a great number of people to the metric system and then letting them decide for themselves which was the more desirable. But there was a flaw in their choice of strategies. By singling out teachers and school children as their main targets, they necessarily delayed the successful completion of their reform by as much time as it would take for this "rising generation" to reach maturity and begin to demand a change. This was not consistent with the Bureau's plan to secure a rapid popular adoption and then disband. By not putting enough effort into reaching many of their adult contemporaries and by not preparing itself to carry on the work over several decades, the American Metric Bureau was contributing to its own defeat. When a real opportunity arose to secure positive legislative action in this direction 20 to 30 years later, there was no active group in the wings to help organize the supporters of the cause, as both the American Metrological Society and the American Metric Bureau had "petered out" by then. While their efforts may very well have had a noticeable impact on the minds of many young Americans, this gain was gradually lost when the issue ceased being actively pursued.

By 1890, then, the first two American pro-metric organizations had had their day. Both had been created and kept viable through the personal interest and dedication of one man—Frederick A. P. Barnard. While the American Metrological Society was intended to be scientific and permanent, the American Metric Bureau was to have been popular and temporary. Whereas the former was to be more concerned with general metrological reform, the latter was interested only in securing the use of the metric system of weights and measures in the U.S. Both were principally east-coast operations and each, in its own way, developed an important constituency, although these proved to be too circumscribed to fully accomplish the organizations' objectives. Finally, both groups accepted the same basic assumption as a point of departure for their activities, namely that the coming of the metric system was an inevitable occurrence which simply had to be properly prepared for. Unfortunately for them, the problem as it eventually emerged was not that elementary.

D. THE LEGISLATIVE SCENE: 1877-1886

The most noticeable effect of the pro-metric agitation was the reappearance of the issue in the legislative arena, beginning in 1877 and lasting for 10 years. For the most part, the bills proposed were along the lines advocated by the Metrological Society and were designed to effect the partial adoption of the metric system by the U.S. Government, especially in its international dealings. As the Chairman of the House Committee on Coinage, Weights, and Measures at that time, Alexander Stephens of Georgia, had already indicated his sympathetic attitude toward the metric movement by joining the Society, the legislation that was sought during this period was probably inspired by the Society's recommendations.

Also leading up to legislative consideration of the question, and having a definite effect on the scope of it, were some new investigations of the subject by independent bodies and individuals. The first of these was made by a standing committee on the metric system of the Boston Society of Civil Engineers between 1873 and 1875, and was discussed by the American Society of Civil Engineers [67]. This group was in favor of the metric system because of its potential advantages to civil engineering, and it advocated petitioning Congress to fix a date after which the metric system would become the *only* legal one in the U.S. After some discussion, the American

Society of Civil Engineers finally adopted, in 1876, a resolution calling upon Congress to require the exclusive use of the metric system in official Government documents and reports.

In August of 1876 a committee on weights, measures, and coinage of the American Association for the Advancement of Science, chaired by Dr. Barnard, submitted a report dealing with some pending metrological questions [68]. After first urging the Senate to ratify the "Treaty of the Meter," this committee specifically noted that there existed a large body of "well-known men who have publicly expressed their unwillingness to see the metric system of weights and measures made compulsory in the United States." Therefore no resolutions urging metric adoption were offered although the committee did go on record as being in favor of action to maintain the gold standard as the only metal to be used in coining money.

A third, and even more strongly-worded, report was submitted to the Franklin Institute at Philadelphia in June, 1876 [69]. Their investigation, headed by Coleman Sellers (famous for his development of the most widely-used system of standard screw thread sizes in the U.S.) was triggered by the action of the Boston Society of Civil Engineers, which had sought the Institute's cooperation in petitioning Congress to make the metric system mandatory. In its own way, this particular investigation was also to become a touchstone for later metric debates due to the high esteem in which Mr. Sellers was held and the forcefulness with which he stated his objections to the system.

Sellers first contrasted the situation in pre-metric France with the existing situation in the U.S. in order to demonstrate that our need for weights and measures reform was not nearly as serious as hers had been. This was done very effectively, leading to the conclusion that:

> "[W]hatever were the controlling reasons which incited the opposition to a change in France, they have much greater force with us from the absence of motive. We have no such confusion and diversity as the French had, and no such reform is called for. Our money is already decimally divided, and we enjoy already the chief benefits which the new system gave to the French [70]."

Other points raised in opposition to the metric system were simply amplifications of ones which had been raised before—the fact that the meter was now as arbitrary a standard as the foot, the opinion that it was less convenient than a two-foot rule for practical purposes, and the notion that all land measurements would be invalidated, for example. Sellers went beyond this, however, and, for the first time brought up the question of the costs of making a change and who would have to bear this expense:

> "[T]he industrial arts during the last fifty years have acquired a far greater extent and precision than were ever known before . . . It has been calculated that in a well regulated machine shop, thoroughly prepared for doing miscellaneous work, employing 250 workmen, the cost of a new outfit adapted to new measures, would not be less than $150,000, or $600 per man [71]."

This could be contrasted with the claim made by contemporary advocates that adoption of the system would lessen the number of computations involving fractions and so would result in saving one whole year of educational time for each child [72]. While neither claim was ever fully substantiated to the satisfaction of all, Mr. Sellers' argument would certainly seem to be the more comprehensible of the two, especially to a workman or shop owner.

Nor did the Franklin Institute committee believe that it was feasible to simply keep all of the current standard sizes as they were and simply substitute metric labels (calling a 1-inch bolt a 2.54 centimeter bolt, for example) because of the difficulty of translating from one system to the other. Finally, the Sellers committee was opposed to the metric system because it believed that metric adoption would nullify all of the existing technical literature that was based on the English customary system.

Taking all of these things into consideration, the conclusion was reached that:

"To the teacher, to the closet scholar, to the professional man, to those who never handled a rule or measure, but only use weights and measures in calculation, it may seem merely a matter of legal enactment; but to the worker, the dealers in the market places, to those who produce the wealth and prosperity of the land, the question is a most serious one [73]."

Such detrimental accusations could not go unanswered, of course, and a civil engineer named John W. Nystrom was quick to step in and challenge the opposition head on. Writing first in the same journal that had published the Sellers report and later in a separately published book [74], he attempted a rebuttal in much the same manner that Barnard had employed 5 years earlier, i.e. on an argument-by-argument basis. Nystrom was not able to marshal an impressive array of facts with which to counter Sellers, however, so he attempted to do so by claiming that the objections raised were "of mere temporary and insignificant import, very much like the English objections to the introduction of the Arabic figures for the Roman notation some 300 years ago."

By 1877, then, the question of what to do about the metric system in the United States was ripe for Congressional consideration.

1. POLLING THE EXECUTIVE BRANCH

On November 6, 1877, Representative J. B. Clark of Missouri introduced the following resolution, which the House immediately adopted:

Resolved, That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by Act of Congress; . . . and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public

> service; and . . . they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States[75].

The reason for this resolution, apparently, was a simple desire to collect what facts there were and to ascertain what the executive branch thought of the idea that it should be used as the most appropriate medium for introducing the metric system to the American people. Judging from the wording of the resolution, it also appears that Representative Clark believed that the gist of the Government's response would constitute an endorsement of the metric system.

If such was the case, the replies of the executive branch officials who responded are all the more noteworthy for, on the whole, the opinions expressed were cautious, if not altogether discouraging, about the desirability of any forceful action leading to metric adoption [76]. Many agencies answered the call, including the Departments of State, War, Navy, and the Post Office, but the response of Treasury Secretary John Sherman is of special interest because his agencies, above all others, were those that were most heavily involved in the question [77]. Included in the Treasury Department at that time were the bureaus in charge of coinage, customs, internal revenue, government statistics, and the coast survey (a part of which was still the Office of Weights and Measures).

In his letter transmitting the reports of his bureau chiefs to the Speaker of the House, Samuel J. Randall, Secretary Sherman stated:

"I am of the opinion that it is not advisable to make the metrical system of weights and measures obligatory in any transactions at present. The law now legalizes and permits that system to be adopted in all cases with the consent of parties.

While [it] is undoubtedly the more perfect in theory, the old system of weights and measures is so ingrained upon the business habits of our fellow citizens, that a new system should not be adopted until it is well understood and acquiesced in by the body of the people. I think great confusion, many inconveniences, and much litigation would arise from its hasty adoption. Congress might properly, in any revision of the tariff, adopt this system, stating in the law, however, the equivalents of the old in the metrical system; but even this change would create some embarrassment, and is of doubtful utility [78]."

Of all of the Treasury Department opinions submitted, only that of its chief clerk, J. K. Upton, amounted to an unqualified endorsement of the metric system. Mr. Upton believed that the metric system had passed the experimental stage and that the people of the U.S. were certainly adaptable enough to accept it as a boon. The system, he felt, would be especially valuable to our international trade. He offered the following statistics for fiscal year 1877 in support of his position:

Imports from:	*Value of imports*
Nations where metric system was obligatory	$177,807,469
Nations where metric system was partially used	17,378,735
Nations where metric system's use was legal[4]	265,211,585
Nations where metric system was not legalized	23,804,140
Total	484,201,929

Two years, Mr. Upton felt, would be sufficient to enable the Government to prepare for adoption, while a total of 10 or 15 years ought to be allowed before extending the obligatory use of the system to private transactions.

The chief clerk of the Treasury Department's Bureau of Statistics, Mr. E. E. Elliott, was less enthusiastic. He saw no objection to the Government adopting the metric system for transactions of an international character, such as postal exchanges, customs duties, and the like, but was not prepared to recommend that the Congress go beyond that [80].

The most surprising development of all, however, was the essentially negative opinion of the Coast and Geodetic Survey. As expressed by Superintendent C. P. Patterson, "[N]o law [should] be passed upon this subject without the most mature deliberation, and . . . when passed, it should not have compulsory effect until at least thirty five years after the date of its passage [81]."

What made the Survey's report so surprising was that it was drawn up by Patterson's Assistant in charge of Standard Weights and Measures, J. E. Hilgard. This was the same Mr. Hilgard who was a founder and council member of the American Metrological Society and who had been, and still was, representing the United States in the international reformulation of the metric system!

Mr. Hilgard's report is outstanding for its clarity, brevity, and eminent good sense [82]. He approached the question systematically, analyzing the impact of possible metric adoption upon the Coast Survey, upon the operations of other bureaus in the Treasury Department, and, finally, upon the people at large. Noting that the Coast Survey already used the metric system "to the full extent that is consistent with the usefulness of the form in which the results are given to the people," he expressed the fear that the exclusive use of metric units would deprive the Survey's charts of much of their usefulness.

Other operations in the Treasury Department would be heavily affected, Hilgard observed, especially those dealing with coinage, customs, and internal revenue. Aside from a few technical problems, he found no real objection to basing American coinage on the system. As for using the metric weights and measures to assess duties on imports:

"[G]reat inconvenience would arise from the want of familiarity with that system of the officers assessing the duties. It must be borne in mind that the efficiency of such an officer depends in the greatest degree upon his familiarity with the values of goods

[4] Included Great Britain and possessions.

> submitted to his inspection, and that he cannot separate in his mind the expression of measure from that of value . . . The transformation into other terms of measure will break away entirely from his habits of thought, and his experience is practically lost [83]."

Similar objections applied to the operations of the Internal Revenue Department, whose chief activities at that time were collecting taxes on tobacco and alcoholic spirits:

> "[T]he liability to error would be greatly increased, and . . . the manufacturer and dealer would lose the advantage they now have, and which is fairly due them, of having the taxed value of the product expressed in quantities that are customarily used in their trade [84]."

As for making the metric system compulsory in private transactions, Mr. Hilgard foresaw: (1) difficulties in enforcing an obligatory statute, since even penalties would not be able to fully suppress the use of the pound, inch and gallon; (2) a very slow process of natural growth, perhaps more than 50 years, if the system were allowed to develop by itself; and (3) costs and difficulties in making changes in machinery that were greater than most metric system advocates assumed them to be.

But Hilgard was not opposed to the introduction of the metric system, only to hasty action to achieve it. His own recommendation was that:

> [The next step ought to be] "the enactment of laws requiring [its] use in such government transactions as will not suffer by the sudden change of the habits of men. There, perhaps, legislation must stop for a long while, until by zealous inculcation, by agitation, by instruction in all public schools, the new system shall have been voluntarily adopted by a great majority of the people, when the enactment of an obligatory law will only be the consummation of an existing state of facts.
>
> It has ever been the practice of the Anglo Saxon people to make laws in conformity with customs, not to create customs by compulsory laws [85]."

The replies of the other departments of government in response to the House of Representatives' resolution were no more enthusiastic, although some had no strong opinions one way or the other. The Secretary of State, for instance, observed that Great Britain and her dominions were still employing the customary system and that some commercial dislocations might result from our adopting the metric system [86]. The Postmaster General estimated the immediate expenses would amount to about $125,000 and that other annoyances would result [87]. The War Department was divided on the question, with the Chief Engineer favoring adoption and others, such as the Quartermaster General, being opposed [88]. Taken as a whole, then, the responses indicated that the time was not altogether auspicious for legislation requiring the executive branch to serve as a means for disseminating the metric system throughout the United States.

2. FURTHER CONGRESSIONAL CONSIDERATION

As these replies were received, they were referred to the House Committee on Coinage, Weights, and Measures for evaluation and appropriate action. Without waiting for all the opinions to come in, however, Mr. Stephens, the Committee's chairman, introduced a bill,[5] on January 29, 1878, "to enable importers to use the metric weights and measures." The purpose of this bill was to permit the assessment of tariff duties to be made on the basis of metric units. This revision of Government procedure would save customs inspectors the labor of having to first translate an invoice into English units before figuring the amount of duty to be paid.

Hearings on the subject were conducted by the committee later in the year (at which time the question of the American share of funding for the new International Bureau of Weights and Measures was also discussed), with Hilgard as the only witness [89]. The following year, in January, 1879, a committee report was sent to the House by Representative Levi Maish along with a substitute bill [90].[6] This bill specified that, by July 1, 1880,

"[T]he Postmaster-General shall furnish all post offices with postal balances denominated in grams of the metric system, at an expense not exceeding fifty thousand dollars, [and] . . .

[T]he metric system of weights and measures, as legalized in section thirty-five hundred and sixty-nine of the Revised Statutes, shall be obligatory in the assessment of duties on imported commodities in the custom-houses of the United States."

The report itself presented an extensive explanation of the essential features and the international growth of the metric system. It had been prepared by Mr. C. P. Culver, the Committee's clerk, and he appended a wealth of supplementary material pertaining to the existing status of the system [91]. The evidence and arguments presented had led the Committee to conclude:

"We are well satisfied . . . that this new or metric system of weights and measures is rapidly gaining ground both in this country and Europe, as one after another the most enlightened nations awake to the full appreciation of its immense advantages [92].

Indeed, the metric system has received the support of statesmen and the earnest sanction of scientists both in the New and the Old World for the past half-century or more; and we cannot therefore longer treat with indifference the numerous appeals that are being made to Congress, from time to time, by the scientific and business men of the country, urging the adoption of the system in such departments of the government, at least, as have the largest relations with those countries and nations which have already adopted it in whole or in part, as an earnest of our purpose to adopt it in whole in all government transactions, so soon as

[5] H.R. 2877.
[6] H. R. 2699.

> our people are educated up to the point in its use that they will prefer the new . . . system . . . [and] to secure this desirable end your committee . . . recommend the early passage of House Bill No. 2699 [93]."

But time was running out on the 45th Congress, and the bill expired with it on March 3, 1879, without having been brought to the floor for discussion and a vote.

In the 46th Congress, which convened on March 18, 1879, and in all of the several succeeding Congresses, similar metric system legislation was proposed. One of these, *H.R. 409* of the 46th Congress, providing for the direct assessment of duties on metric invoices, was introduced by an Ohio Congressman named William McKinley. McKinley's later involvement with tariff questions, as well as with coinage matters, was to go much deeper than just specifying which system of weights and measures they should be based on. In 1890 he led the fight for higher tariffs to protect infant industries and, as a successful Presidential candidate in 1896 on the "gold standard" of coinage platform, McKinley was the main target of William Jennings Bryan's famous "Cross of Gold" speech. His advocacy of metric legislation in 1879, however, did not result in the enactment of any laws, although his bill was reported favorably by the Committee on Coinage, Weights, and Measures and sent to the Committee on Ways and Means. In June, 1879, Representative Maish revised and enlarged his report of the previous January and once again recommended a limited introduction of the metric system by and through the executive branch [94]. The outcome of this attempt was no different than that of the previous one, and the question remained unsettled.

During this same general time period (1876-1886) several bills were introduced to provide for adopting a metric coinage system.[7] Under the terms of these proposals, both the weight of the gold used in minting U.S. coins and the diameters and other dimensions of the coins were to be specified in metric units. This subject occupied a large part of the Committee's time and resulted in the issuance of a great deal of printed matter [95], but little else, for no action was forthcoming from the Congress as a whole.

A peak of activity indirectly related to legislation was reached in late 1879 and 1880. The National Academy of Sciences again expressed its opinion on the question, resolving that laws should be enacted to require use of the metric system in postal affairs, customs work, and coinage [96]. A committee of the American Social Science Association, under the chairmanship of Dr. Barnard, turned over to the Congress a set of pro-metric resolutions and an accompanying report lauding the system [97]. An interest group violently opposed to the metric system's introduction in this country was formed in Boston in November, 1879, about which more will be said in the next section, and, in 1880 the newly-formed American Society of Mechanical Engineers lined up in opposition to metric legislation. Also, in March, 1880, the House Committee printed a report containing a plan for a new, non-metric

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[7] H.R.'s 410, 411, 412 and 1911 of the 46th Congress are prime examples of this type of Bill.

decimal system and a pro-metric refutation of the proposal prepared by the clerk, Mr. Culver [98].

This plan, devised by a Col. Thomas S. Sedgwick, proposed to redefine and "decimalize" the English system. To start with, the "foot" would remain unchanged but it would be divided into 10 inches, each two-tenths of an inch longer than the existing inch. A new "mile" of 5,000 feet would be adopted, and the "acre" would be defined as 40,000 square feet (an 8% reduction). Similar changes, laboriously conceived, were proposed for measures of weight and capacity. Sedgwick's proposal was not based on the assumption that his change would be any easier to make than adopting the metric system, since it would obviously be just as difficult to implement, if not more so. Rather, he felt that the English customary system, while in need of simplification, was preferable in nomenclature to the metric system and that it was destined to become the universal "language" of world trade because of America's burgeoning commercial superiority.

Mr. Culver, writing on his own initiative and not in his capacity as staff to the House Committee, felt differently. The nation's objectives in seeking metrological reform ought to be uniformity, permanency and universality, he said, and only the metric system offered an opportunity to achieve all three simultaneously. The language problem could be overcome by simply adapting the English system's names to the units of the metric system, so that a meter could be dubbed a "metric yard," a liter a "metric quart" and so on. Culver claimed that "commercial embarrassment" would accrue to the U.S. if we didn't soon begin to increase our use of the metric system, and he also felt that America's ratification of the Treaty of the Meter constituted a commitment on our part to move in this direction.

Although no changes resulted from this small confrontation, it exemplified some of the characteristics of this era in the history of the metric system in the U.S. For one thing, it demonstrated that a wider interest was developing with regard to the system of weights and measures used in this country. Even though concern over this issue cannot be called one of the most pressing questions of the age, it had progressed to the point where even private citizens were aware of the problem and attempting to devise whole new systems of weights and measures [99]. The Sedgwick-Culver exchange was also indicative of a shift in America's general outlook which had occurred by 1880. Considerations such as the primacy of the English language, American inventiveness, and U.S. prestige in world politics and commercial dealings were being brought to bear on the metric issue, and with adverse consequences. This new attitude toward our position in world affairs was typical of the period in general, as noted in a recent work by Samuel P. Hays:

> "The two decades of economic expansion between 1874 and 1894 witnessed a party politics that reflected the spirit of the age: reckless, competitive, blustering, and devoted to the nation's rapid material growth [100]. . . .
>
> As the United States grew in industrial might, it rose to greater prominence on the world scene and assumed a more positive and vigorous

> role in international affairs. During the 19th century Americans had turned their energies toward internal economic development. In the eighties and nineties they increasingly engaged in economic, strategic, and cultural enterprises abroad and demanded that their government protect and promote their new ventures [101]."

The effect of this aggressive attitude would become obvious in the controversy over the metric system very shortly.

Closing out this era on the legislative scene, a Joint Resolution was passed by the Congress on March 3, 1881, requiring sets of standards to be supplied to State land-grant colleges by the Treasury Department, and three more metric bills were proposed between 1881 and 1886.[8] By this time, the nature of the legislation being introduced was beginning to change slightly. Bills in the later sessions called for the exclusive use of the metric system in all Government business and required that the system be taught in all schools and colleges receiving Federal assistance. Enthusiasm for metric legislation had waned by the mid-1880's, however, as none of these bills were even reported on by the Committee on Coinage, Weights, and Measures. It was to be nearly 10 years before serious consideration was again given to the issue by Congress.

One possible reason for the failure of metric advocates to attain their desired ends during the 1870's and 1880's was the emergence of vocal opposition to the system in organized form. While the actual influence of the International Institute for Preserving and Perfecting (Anglo-Saxon) Weights and Measures[9] may have been less than its leader claimed for it, it nevertheless was the first group formed especially to oppose the introduction of the system in this country and it followed a unique and interesting philosophy in doing so.

E. THE REVELATIONS OF THE GREAT PYRAMID AND THE INTERNATIONAL INSTITUTE

Because the anti-metric stance of the International Institute was derived from the tenets of a most unorthodox contemporary movement known as "pyramidology," a brief review of this fad is in order before examining the Institute's activities.

1. PYRAMIDOLOGY

The object of the pyramidologists' attention was the ancient Egyptian pyramid-tomb of King Khufu at Giza [102]. By carefully interpreting its location, dimensions, and other physical characteristics, generally by means of involved mathematical manipulations, a small but dedicated band of 19th

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[8] H.R. 112, 47th Cong., 1st Session (1881); H.R. 7492, 48th Cong., 1st Session (1884); and H.R. 2119, 49th Cong., 1st Session (1886).

[9] Hereafter referred to as simply the International Institute.

century eccentrics (including at least one otherwise respected scholar) were able to "prove" the heaven-sent origins of the pyramid as well as the validity of certain Biblical passages and analogies. The main aim of this endeavor was to demonstrate that the building of Khufu's final resting place had been directed by the hand of God and had been, in reality, intended as a repository for His scientific gifts to mankind, including measurement standards and the immutable laws of physics, mathematics, and astronomy. As Willy Ley, the modern science writer, says of the progenitor of this theory: "If Taylor had been an American, he might have said that it was the Egyptian equivalent of the Bureau of Standards, with the additional twist that all the standards are 'classified information' not meant for the average dumb citizen [103]."

The Taylor referred to was John Taylor, a London publisher, who had written and published, in 1859, a book entitled *The Great Pyramid, Why Was It Built? And Who Built It?* After studying second-hand the archeological records of that day relating to the pyramid,[10] Taylor concluded that its architect must have been an Israelite carrying out God's plan [104]. As evidence to support this, he noted many mathematical relationships that were possessed by the pyramid that went beyond the knowledge of ancient Egyptians. For instance, Taylor believed the Great Pyramid had been constructed according to a "sacred cubit" of about 25 inches that represented one four-hundred-thousandth of the earth's axis. He also believed this to be the same measuring unit used in the construction of Noah's ark, Solomon's temples and other architecture referred to in the Bible. Finally, he concluded that the pyramid as a whole symbolized nothing less than the true Church with Christ as the capstone.

In 1864 Taylor's work was taken up by the most zealous of all pyramidologists, a man named Charles Piazzi Smyth, a very competent scientist and the Royal Astronomer for Scotland. His first work on the subject was called *Our Inheritance in the Great Pyramid* and it, especially in its later editions, received a great deal of attention. Smyth also published a number of works based on his personal research at the Great Pyramid [105].

Smyth's "discoveries" are summarized best by Martin Gardner in *Fads and Fallacies in the Name of Science.*

"To begin with, Smyth discovered that the base of the Pyramid, divided by the width of a casing stone, equaled exactly 365 – the number of days in the year. . . . The stone measured slightly more than twenty-five inches, and Smyth concluded that this length was none other than the sacred cubit. If we adopt a new inch–Smyth calls it the 'Pyramid inch'–which is exactly one twenty-fifth of the width of the casing stone, then we obtain the smallest divine unit of measurement used in the monument's construction. It is exactly one ten-millionth of the earth's polar radius.

[10] And these were by no means as complete or as authentic as they would become during the 1881-1922 period when Great Britain occupied Egypt.

> Somehow, it had been passed on through the generations, [Smyth] believed, until it became the Anglo-Saxon inch, but in the process altered slightly, making the British inch a trifle short of the sacred unit. . . .

With incredible zeal, Smyth applied his Pyramid inch to every measurable portion of the Pyramid, inside and out, to see how many scientific and historical truths he could discover. These he found in great profusion. For example, when the height of the Pyramid is multiplied by ten to the ninth power, you obtain a distance which approximates the distance from the earth to the sun. Similar manipulations of Pyramid lengths give you the earth's mean density, . . . the mean temperature of the earth's surface, and many other scientific facts only discovered in recent times [106]."

Other pyramid measurements revealed to Smyth the means for calculating the dates of greatest importance in man's past and future. This was done by measuring the edifice's internal passageways, in pyramid inches, and interpreting them on a ratio of 1 inch to 1 year. By this method, Smyth predicted the Second Coming of Christ sometime between 1882 and 1911, depending upon how the measurement was made [107].

Another aspect of the Great Pyramid which Smyth and others found to be fraught with mystical symbolism was the "intense *fiveness*" exhibited by it. For instance, the pyramid has five corners and five sides and the pyramid inch was one-fifth of one-fifth of a sacred cubit. This was said to correspond with many natural phenomena such as the five senses, the five digits at the termination of each limb of the human body, the five books of Moses and so on, all part of God's grand plan.

From these precepts it naturally followed that King Khufu's burial coffer was intended to serve as a capacity standard, with weight units being derived from the amount of water it would hold. The burial chamber itself was obviously intended to be a touchstone for temperature measurement because of its constancy. Finally, the pyramid symbol *in toto* had been passed along as God's intent to denote the superiority of the Anglo-Saxon race, according to the most rabid pyramid devotees, as evidenced by the liberal use of it in the western world (see, for example, the reverse of the Great Seal of the United States, which is printed on the back of every $1 bill). Clearly, no right-thinking person could, in the light of these startling revelations, accept the heretical, man-made, French metric system of weights and measures in preference to our heaven-sent customary ones!

Contemporary and modern scholars who have taken the trouble to investigate the beliefs of the pyramidologists have had little difficulty in debunking their pretensions. First of all, in a structure the size, shape and complexity of the Great Pyramid, there are an almost infinite number of dimensions that can be measured and interpreted to suit one's purpose. Secondly, the dimensions of the pyramid were, and to some extent still are matters of conjecture. The pyramid is not now whole, its facade having long since crumbled, and what is left has been eroded by wind and sand for hundreds of years. Finally, the figures which Smyth chose to represent scientific constants (the distance from the earth to the sun, for example) were equally vague in his day and are only now beginning to be more precisely known.[11] In sum, Smyth was dealing with a considerable number of variables which he was at liberty to manipulate to serve his own apparently sincere, but misdirected, ends [108].

Gardner also gives a very amusing example of how such a thing can be easily done in a convincing way by someone wishing to confirm his most cherished theories:

> "Just for fun, if one looks up the facts about the Washington Monument in the *World Almanac*, he will find considerable fiveness. Its height is 555 feet and 5 inches. The base is 55 feet square, and the windows are set at 500 feet from the base. If the base is multiplied by 60 (or five times the number of months in a year) it gives 3,300, which is the exact weight of the capstone in pounds. . . . and if the weight of the capstone is multiplied by the base, the result is 181,500—a fairly close approximation of the speed of light in miles per second. If the base is measured with a 'Monument foot,' which is slightly smaller than the standard foot, its side comes to 56 1/2 feet. This times 33,000 yields a figure even closer to the speed of light [109]."

But the validity of the pyramidologists' arguments was not the issue at hand. Eccentric, racially-biased and wrong as they may have been, their theories were accepted unquestioningly by a large enough number of religious and other groups to give a widespread notoriety to them, not only in Great Britain and the United States, but in other countries as well.

One of the most visible and outspoken adherents of this often-confusing philosophy was the self-proclaimed International Institute for Preserving and Perfecting (the Anglo-Saxon) Weights and Measures.[12]

2. "THE BATTLE OF THE STANDARDS"

From the very beginning, the Institute was preoccupied with symbolism. Its founding took place on the date its organizers took for the anniversary of the arrival of the Mayflower off Plymouth rock, November 8 (old-style calendar). On that date in the year 1879, three men met in Boston's Old South Church and agreed to found the Institute. These men were Lucian I. Bisbee, G. M. Hardy, and Charles Latimer [110].

Taking their cue from the Biblical exhortation that "Thou shalt have a Perfect and Just Weight, a Perfect and Just Measure . . .," three interrelated objectives were proclaimed. First, the Anglo-Saxon system of weights and measures was to be preserved and perfected. Second, any legislation or

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[11] One of the primary Apollo 11 scientific experiments, for instance, was to place a prism device on the lunar surface so that a laser beam could be bounced back to earth from it, thus determining with precision the distance between the earth and the moon for the first time.

[12] The words "Anglo-Saxon" have been included in parentheses because they were sometimes included and sometimes excluded from the Institute's title on official publications.

other measures designed to inflict the French metric system on the American people were to be opposed. The third purpose was to be "the discussion and dissemination of the wisdom contained in the Great Pyramid of Jeezeh in Egypt [111]." At that time, President James A. Garfield, then a member of Congress, was elected to head the Institute, Charles Latimer of Cleveland was elected first vice president, and Charles Piazzi Smyth, although not in attendance, was named as a counselor [112]. When Garfield declined to serve, Latimer automatically took over as President.

About all that occurred of a constructive nature during the Institute's first 3 years of existence was the formation by Latimer of an Ohio Auxiliary Society in Cleveland. This "branch" of the Institute became the real headquarters for its operations (in fact, there was only one other "branch" ever formally organized, that being one in the New York-New Jersey area) and Charles Latimer became the group's life blood, financially and philosophically. For this reason, a few words about his life are appropriate at this point [113].

Charles Latimer was born in Washington, D.C. on September 7, 1827. After graduation from the U.S. Naval Academy he spent 13 years in the Navy as an engineer, turned to steamboating for a brief period, and finally found his ultimate career in railroad engineering. His greatest contributions to this last-mentioned field came as chief engineer, and later an engineering consultant, to the New York, Pennsylvania, and Ohio Railroad. In this connection he not only built the line into an attractive candidate to be taken over by the Erie system but also contributed several inventions to railroad safety, including a bridge-guard named after him. Outside of his civil engineering talents, Latimer was known not only for his advocacy of customary weights and measures but also for his use of the divining rod in prospecting ventures and for his "mesmeric power over others, which he could exercise at will" [114] but from which he was said to have abstained on conscientious grounds.

As to his personality, most of his memorialists were willing to concede a kind and tender-hearted side to the man, although they readily admitted that few had ever seen it first-hand. He was extremely hard working, tenacious in his convictions, profoundly religious, and, according to some accounts, singularly tolerant of those who ridiculed him for his unusual beliefs.

At the age of 61, on March 25, 1888 Latimer "was stricken with apoplexy . . . [w]hile on his knees at morning family prayer [115]." As with Barnard, the active efforts of his organization died with him, but not before some damage had been done to the metric cause.

According to his friends, Latimer's interest in pyramidology began in 1878 when he happened to read Smyth's *Life and Work at the Great Pyramid* and *Our Inheritance in the Great Pyramid*. Becoming convinced that the pyramid held the key to unlock the mysteries of the past and that it was positive proof of the divine origin of the inch, Mr. Latimer began a personal program of research and study into the subject. Out of this came the International Institute, at first consisting only of close friends but later expanded by his own diligent efforts.

His first printed contribution to the cause took the form of a vituperative denunciation of pro-metric efforts in an 1880 book entitled *The French Metric System, or, The Battle of the Standards* [116]. Its avowed purpose was the "awakening of the advocates of the French system to the defeat that lies before them."As the content of this brief (64 pages) book defies adequate paraphrasing, a few extracts from it will help to make Latimer's position crystal clear:

"The followers of Darwin, and the infidel will both deny the inspiration of our weights and measures, and ascribe all of our progress to a natural progression; and, doubtless, will hail the appearance of the new French unit as another argument in favor of their peculiar views and theories, and will be equally ready to re-adopt the fantastic freaks of the French Revolution, even to abandoning the Sabbath and burning the Bible [117]."

"It may be thought by some unreasoning persons that there has been so much said and done with reference to the French metric system, that there now remains nothing more to be said or done but for Congress to issue its edict, and that thereupon the French metric system will be at once an accomplished fact and the law of the land; and to this end, certain inconsiderate persons, in addition to schemers for gain, are devoting a large amount of ink and paper, to say nothing of brains, in getting members of Congress, emulous of fame and ambitious of handing their names down to posterity, to act as the champions of pet schemes of these 'closet philosophers.' To these gentlemen it may be well to say . . . How dare you attempt to foist upon us without our consent new weights and measures unknown to us and to our fathers? Understand that we will, with one blast of our mouth, cast down your false measure [118]. . ."

Mr. Latimer was not to find that one blast was enough.

Three years later, God having given him the financial means, Latimer began publication of *The International Standard* as the official organ of the Institute. The issuance of this periodical was made possible by his discovery of the Witch Hazel Coal Mine near Youngstown, Ohio, a find for which he is reputed to have relied on his divining rod. At any rate, he sold his interests in the mine and used the royalties to sustain the Institute. Although other sources were sought from time-to-time, principally the sale of memberships, Latimer's revenues from the coal mine were all that kept the organization alive, as evidenced by the fact that publication ceased immediately upon his death, with the voluntary contributions received thereafter being only enough to fund one more issue. Before it went down for the final time, however, the *International Standard* has recorded a unique chapter in the history of the metric system.

In his 1882 address to the annual meeting of the Institute, Latimer noted the progress made by it during the past 3 years (during which time only the desultory *Proceedings* of the Ohio Auxiliary Society had been printed):

"[W]e have checked the onset and forced the advocates of the French system to the defensive here. Before our organization they had it all their own way. Bill after bill favoring the metric system was pressed upon Congress with hope of passage. Strong pressure also was brought to bear upon the executive departments of the country, so that persons high in authority were persuaded and influenced to issue orders to subordinates in the name of the Government to use only the metric system. . . .

I believe I state the exact fact when I say that the memorial of the International Institute [9,000 copies of which were circulated for signature], issued two years ago against this and other bills, prevented their adoption. . . .

The misfortune is that our legislators are not informed upon the merits and demerits of the question. The advocates of the French system adroitly call it the decimal system, and many ignorantly throw up their hats and say: 'Hurrah for the decimal system; we will go for that,' but they do not take time to consider, nor do they know that an utter extirpation of all our hereditary units is sought [119]. . ."

Among other things, Latimer also took this occasion to denounce Frederick Barnard and Alexander Stephens; to urge the defeat of Sanford Fleming's standard time system (Latimer favored making the longitude of the Great Pyramid the prime meridian of the world); to announce that arrangements had been made with the *Cleveland Herald* to publicize the Institute's activities; to seek financial support for a personal expedition to the Great Pyramid (a continuing goal which he never achieved); and to urge the current 401 members to expand their number so as to improve the financial status of the International Institute.

This initial article was probably the most lucid ever to appear in the *International Standard* as, over the next 6 years, the magazine consistently jumbled together anti-metric blasts and pyramid theories. Although opposition to the introduction of the metric system was an aim of the Institute, it would perhaps be more accurate to speak of this organization as primarily a "pyramid society," as a glance at the subject matter of the articles published in1883 will show. Of a total of 65 articles printed, no less than 35, or about 54 percent, dealt primarily with pyramid-related topics. The titles illustrate the somewhat bizarre interests of the Institute's membership: "The Great Pyramid and the Geographical Position of Jerusalem," "Zechariah's Visions of the Pyramid Capstone and of the Wicked Measures," and "The Unveiling of Isis." Some of the other popular subjects discussed by the Institute were: (1) the notion that the Anglo-Saxons were the Lost Ten Tribes of Israel, (2) the reasons why the Meteorological Society's recommendations on uniform international coinage and standard time zones ought to be defeated, and (3) different ways of interpreting symbolically the Great Seal of the United States. In short, opposition to the metric system was not the International Institute's only undertaking, but it was an important one. The fact that its opposition was based on an emotional reaction to its origins, not on any pragmatic grounds or intrinsic faults in the system, was immaterial since the results were all that mattered.

A few of the *International Standard's* less-oblique assaults on the metric system demonstrate the Institute's (and especially Latimer's) unwavering attitude on this issue:

January, 1884—"We again meet . . . with an earnest and unflinching purpose to move forward in our work of investigation until we prove to those of our people who are running after new theories the falsity of the new system of weights and measures called the Metric or Decimal System, propounded by the French School of Atheists, of 1795; and until we prove to the whole world the superior origin and excellence of the Anglo-Saxon units . . . which our forefathers were sworn to protect, and which we, their children, have met to defend [120]."

January, 1887—"La Belle France comes with her statue of 'Liberty enlightening the world' . . . There is only one thing we do not like about the statue, we prefer a statue of liberty measured in good earth-commensurable Anglo-Saxon inches, not in French milli-meters, the result of caprice. We want a Panama Canal laid off in good Yankee feet and earth commensurable miles, not in deci- and kilo-meters. . . .

Thus far we have kept the advance thinkers waiting, knocking always secretly at the door of Congress, trying surreptitiously to get in some compulsory bill . . . How many of our people know that there was a bill passed last Congress appropriating $2,270 for the International Bureau of Weights and Measures, whose avowed object is 'perpetuating forever without change the basic units of the metric system of weights and measures.' That money went to France [121]. . ."

In addition to dedicating themselves to defeating proposed metric legislation before Congress, the International Institute offered a few ideas of its own as to what should be done. These included:

(1) Having Congress quietly repeal whatever statutes existed that gave any legal standing to the metric system;
(2) American abrogation of the Treaty of the Meter at the earliest opportunity; and
(3) Amending the Constitution to secure a guaranteed system (obviously English) of weights and measures not subject to either State or national legislation.

These ideas were never seriously pressed on the Congress by Latimer however, and the Institute contented itself with simply keeping the door closed to the metric system. As long as this could be done, the theory went, no real threat was posed by the metric system because "the language of the world is rapidly becoming Anglo-Saxon, the commerce of the world is controlled by Anglo-Saxons, and the French metric system will go down as certainly under the extension of the English language upon the earth, even in France itself."

Perhaps the apex of the Institute's racially-prejudiced, anti-metric stance

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was reached in 1883 with the composition and publication of its theme song, entitled "A Pint's a Pound the World Around." For this ditty the world is indebted to one Charles A. L. Totten, an active member of the Institute [122]. In a subsequent article outlining his views on the role of music in society [123], Totten took great pains to distinguish between the music of the northern nations and the southern, or Latin, ones:

> "There is nothing in common between the soft love songs of the south and those grand airs that led the northern people on to victory, thanksgiving and to prayer. The former are lays of indolence, and foster what they varnish—*vice*. The latter are the soul outpourings of a fervent people, schooled amid the rigors of the wilderness back into the ways of Him who led them there to plead with them in the north country—they are songs which cherish *virtue* and leave it twined about the heart-strings tuned thereto."

About all that such sentiments accomplished was to invite public scorn and ridicule of the Institute, even leading one newspaper to characterize it as "a gathering of very worthy fossils [124]." Nevertheless, the theme song, written in *allegro marziale* tempo, is, at once, outlandish and indicative of the truly unenlightened views of this group. Two of its more colorful stanzas and the chorus went as follows:

They bid us change the ancient "names,"
The "seasons" and the "times;"
And for our measures go abroad
To strange and distant climes.
But we'll abide by things long clear
And cling to things of yore,
For the Anglo-Saxon race shall rule
The earth from shore to shore.

Then down with every "metric" scheme
Taught by the foreign school,
We'll worship still our *Father's* God!
And keep our Father's "*rule*"!
A perfect inch, a perfect pint,
The Anglo's honest pound,
Shall hold their place upon the earth,
Till Time's last trump shall sound!

CHORUS:

Then swell the chorus heartily,
Let every Saxon sing:
"A pint's a pound the world around,"
Till all the earth shall ring,
"A pint's a pound the world around"
For rich and poor the same;
Just measure and a perfect weight
Called by their ancient name!

In terms of the number of supporters of this doctrine, the Institute compared favorably with its opposite numbers, the American Metrological Society and the American Metric Bureau. From the modest beginnings already noted, the Institute built itself up progressively to 401 members in 1883, about 500 in 1884, and reached a high of 680 in 1887 [125]. Unlike the pro-metric groups, however, very few prominent Americans can be found on the Institute's roles. President Garfield was the only notable mentioned by the Institute, and only then in connection with his having graciously declined to accept the proffered leadership of the organization in 1879 [126]. An unusual aspect of the Institute's membership, however, was the number of women who not only belonged but who participated actively in its operations. A check of the new members accepted by the Ohio Auxiliary Society,[13] Latimer's real base of operations in Cleveland, between 1883 and 1887 shows that 21 women were elected. While small in comparison to the total of 271 members elected during that period, the percentage of women members (almost 8%) was certainly higher than that of the pro-metric organizations, even those striving to reach the teachers. Another significant fraction of the new members added during those years were clergymen (7%) and foreign residents (11%). The great majority, however, were either engineers or were not identified as to profession. Geographically, even within the United States, the Institute's membership was more evenly distributed than either of the pro-metric organizations, although the preponderance of members, as might be expected, were Ohio residents. Latimer's policy on membership was ambivalent. Desirous of securing a stable financial foundation for the work, he was also determined to avoid taking insincere persons into the fold:

> "I beg that none shall be so overweaningly anxious to get members as to bring in numbers of persons without their desire to become members and without their proffer of the fee entitling them to membership; for in many cases persons have been thus accepted and have not acted with the Society.[14] Such persons are a dead weight to the Society. I would not exclude any worthy poor man who is unable to pay as a member, but certainly no one should be entered as a member who has not expressed his desire to become one, either by solicitation or by his own voluntary act [127]."

Financially, the International Institute was no more and no less stable than other metric groups of this period. Beginning in 1884, membership dues were set at $2.00 a year and included a subscription to *The International Standard* [128]. The treasurer's report for the year ending November 8, 1885, showed that receipts from outside sources had amounted to $767.43, while Latimer's private funds and Witch Hazel Mine Royalties had contributed $1,361.77 to the Institute's war chest [129]. The same report

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[13] As reported in *The International Standard.*

[14] In spite of Latimer's having chosen the name "institute," he continually referred to it as the "society."

showed that over the past 6 years, $12,452.69 had been taken in by the Institute, against which expenditures had been $12,451.64, leaving a balance of $1.65 [130]. As with the American Metric Bureau, this constant state of near-bankruptcy led to appeals for monetary help on a number of occasions.

In the end, it was the loss of Latimer's financial support after his death which caused the collapse of the Institute. The final regular issue and the memorial issue of *The International Standard* made the plight of the remaining members quite clear:

> "He leaves this work without a leader. But if, as Mr. Latimer always believed, the work is God-appointed, He is able to raise up someone to carry it forward [131]."

> "It is probably known to all the members that the Institute has not been self-supporting, and that Mr. Latimer regularly supplied deficiencies as they occurred from month to month out of his own funds . . . It is the SPECIAL REQUEST of the publishing committee . . . that EACH MEMBER, throughout the country and the world, on reading this announcement will *immediately* send at least a few words . . . promising your aid and support in this enterprise [132]."

This was not to be, however, and the International Institute for Preserving and Perfecting (the Anglo-Saxon) Weights and Measures simply disappeared after that time.

What it had accomplished, if anything, during its 9-year existence can never be explained in concrete terms. Perhaps the most that can be said about its impact is that it was *there*, to oppose pro-metric efforts in a vocal fashion which could not be ignored and to serve as a vigilant watchdog on behalf of those who were inclined to side with objectors to the metric system. The Institute also left a written record of one of the most unusual approaches to the question of weights and measures of any day or age. And yet, considering the spirit of contemporary America, proud and belligerent, the Institute's philosophy may not have been as strange as it now seems. The International Institute was an enigma. To what extent did it contribute to the undeniable failure of efforts to introduce the metric system in the United States during the 1880's? The answer to that question cannot even be reasonably speculated on at this late date for, above all else, the Institute was a product of the age in which it existed.

F. RECAPITULATION

Between 1866 and 1890, a major legislative push to secure adoption of the metric system in the U.S. had come and gone. If it is to be characterized at all, it should probably be termed "the Barnard era," as the single most potent force acting in this direction during that time was President Frederick A. P. Barnard of Columbia College. Through his personal efforts two pro-metric interest groups had been formed and carried on the fight, more or less actively, to bring about metrological reform in the interests of international uniformity. Many committees of prestigious societies and dozens of prominent individuals had also been induced to support this cause by virtue of Barnard's personal reputation and untiring efforts.

The great goal of "the Barnard era" was to educate as many Americans as possible to the value of the metric system on the theory that it would soon be able to make its own way in the world after the education took hold. But the advocates were also impatient. Unwilling to wait for "the rising generation" to reach maturity they sought to secure, by legislation, a greater use of the metric system by the Federal Government in its own work. Even though an international convention securing the metric system's permanency was ratified by the U.S. during this time, other legislative efforts fell short of enactment. One reason for this may have been that the executive branch itself, when queried in 1877, failed to exhibit any great enthusiasm for a change to the metric system by these means.

Another reason may have been the appearance of active opposition. An anti-metric organization, also the product of a single individual's convictions, succeeded in casting the metric system in a light which could not have made the proposed reform very popular at that particular time in America's development. Building upon a mystical explanation of the metrological revelations of ancient Egypt's "Great Pyramid," the International Institute fought the metric system on the grounds that it was neither God-given nor Anglo-Saxon, two unpardonable attributes.

With the deaths of the respective leaders of the two factions — Barnard and Charles Latimer — about a year apart, the first publicly-conducted controversy over the metric system came to an end. The groups they had led stopped being active influences on the legislative process and, for the time being, no new ones arose to take their place. Not very many years elapsed, however, before a new, and even more hotly-contested, campaign was initiated with a new cast of characters.

V. THE "ENTERING WEDGE" CONTROVERSY (1890-1914)

Only a few years elapsed between the waning of the intense interest in the question of metric adoption that had been generated in the 1870's and 1880's and the time when the issue was revived, but significant social, economic and political changes were occurring in the U.S. during these years. As a result of these changes the next concentrated period of metric activity was to be a transition campaign – a replay of earlier efforts in some respects and a harbinger of future campaigns in others.

This cycle of metric agitation began about 1890, with an attempt to capitalize on a newfound interest in improving commercial relationships with our Latin American neighbors, and eventually spanned more than two decades. The main events, however, took place between 1893 and 1907, during which time the legislative fortunes of the metric system underwent a drastic reversal.

After an announcement by the Treasury Department in 1893 that the Nation's "fundamental standards" would thereafter be metric, and following the inclusion of metric system provisions in weights and measures laws passed in 1893 and 1894, efforts to effect greater use of the system through Congressional action were stepped up. In 1895 another investigation of the problems involved in changing to the metric system was requested by the House of Representatives. In the following year, 1896, the House passed a bill that would have achieved the long-sought goal, but then voted to reconsider its action and finally sent the measure back to the Committee on Coinage, Weights and Measures. This was as close to achieving legislative endorsement as the metric system was to come in this country. Many more attempts were made, however, and a great deal of effort was expended by both sides in putting forth their views.

The bill that almost succeeded was typical of nearly all of the proposed legislation dealing with this subject between 1890 and World War I. This class of legislation would have required that the Federal Government adopt the metric system almost immediately in conducting its affairs. The rest of the U.S. was to follow at some appropriate interval, usually 2 to 5 years later. The theory behind this approach was that the Federal Government, by virtue of its ubiquity, would serve as an ideal "demonstration project" to introduce most Americans to the practical utility of the metric system. The opponents of this idea, who had begun to make themselves heard by 1902, saw the proposition in a different light. In their view a few zealots—scientists, executive branch officials, and a handful of Congressmen—were using this strategy to gain for the metric system a foothold, an "entering wedge" as they called it, from which there could be no easy retreat at a later date should the experiment prove to be a failure. In short, the opponents saw these propositions as tantamount to compulsory adoption of the metric system, and the evidence suggests that their beliefs in this respect were well founded.

In addition to the consistent similarity of the legislation proposed there were some other unusual features about this era in the history of the metric system. For one thing, neither the pro-metric forces nor their opponents chose to organize themselves into special interest groups or societies. Instead, they preferred to work within the framework of groups already formed for some broader purpose or to act as free-lance agents, representing only themselves or small groups of like-minded individuals. As a consequence of this, it is extremely difficult to gauge the extent of the interest in this question that was generated during this period. Lacking published statements and records such as were issued by earlier metric interest groups, the chief sources of information about the events and personalities of this era are the printed records of Congressional hearings on the subject. Fortunately, another outstanding feature of the 1890-1914 campaign was the fact that it was the one most productive of formal Congressional investigations into and reports on the question of metric adoption. Whereas most earlier and later activities were conducted in the outside world, the action during these years occurred mainly in Congress.

Perhaps the most noteworthy aspect of this particular campaign was the fact that opposition to the system's introduction came from an entirely different segment of society than it had in previous decades while the pro-metric forces continued to be drawn from the ranks of scientists, educators and government officials. The new opposition was made up mostly of manufacturers, a class of individuals whose political awareness and power had been increasing steadily with the industrialization of America. Due largely to the personal efforts of two men, Frederick Halsey and Samuel Dale, some major manufacturers and engineering interests became convinced that a forced change to the metric system would have an expensive and disruptive effect on their businesses. They acted accordingly.

The opponents' suspicions were aroused even further when Congress created the National Bureau of Standards in 1901. This action, which expanded the authority and functions of the old Office of Weights and Measures, came to be viewed by anti-metric forces as an attempt to create a Government agency to work for and oversee the further introduction of the metric system. Even though this idea apparently never entered into the decision to create a National Bureau of Standards, the fact that weights and measures came within its jurisdiction was enough to alarm Halsey and Dale. This impression was strengthened by the fact that the Bureau's first director, Dr. Samuel W. Stratton, was sympathetic to the metric cause and actively participated in the debate on the subject.

All of these influences combined to restore the prominence of the metric issue for several years after the turn of the century. By 1907 both sides had been heard by the Congress on many different occasions and it became obvious that they were so far apart that there was no hope of taking any positive action to increase the U.S. use of the metric system. At that point, enthusiasm began to wane again and both sides withdrew to await further developments.

A. EARLY DEVELOPMENTS

Organized metric activity had come to a virtual standstill by the late 1880's. With the passing of the outstanding leaders of the previous campaign, Frederick Barnard and Charles Latimer, the interest groups that they had kept alive through personal dedication ceased to function. Of the three groups formed during the previous decade, only the American Metrological Society continued in existence and even its strength and vitality were gone. The object of their attentions, the "rising generation" of an earlier day, was either not interested or had been so well versed in the advantages of the metric system that they took for granted its eventual acceptance. The Congressional unit responsible for such matters, the House Committee on Coinage, Weights and Measures, had become increasingly embroiled in a controversy that was destined to engage the whole Nation, and so it allowed the metric question to lie undisturbed for several years. The executive branch of the government, however, maintained a continuing interest in the metric system's domestic and international potential during these years and it was from this source that the impetus for a new campaign came.

The convening of the first International American Conference in October, 1889 provided the first opportunity to reawaken interest in the metric system. The personal project of Secretary of State James G. Blaine, this conference had been on the drawing boards for several years. Its principal purpose was the improvement of U.S.-Latin American economic relations—Secretary Blaine desired to lay the groundwork for a Pan-American customs union that would give preferential tariff treatment to American products in all American countries on a reciprocal basis [1]. Although this objective was not achieved, the conference provided an excellent opportunity to impress upon Congress the fact that most of our neighbors to the south had officially adopted the metric system of weights and measures. Accordingly, the Superintendent of Weights and Measures in the Treasury Department, Thomas C. Mendenhall, transmitted his opinions and recommendations on the subject to Secretary Blaine along with information for the use of U.S. delegates to the Conference [2]. As was the case with his predecessors in that office, Dr. Mendenhall was thoroughly convinced that it would be in the Nation's best interests to adopt the metric system, and he so informed the Secretary of State. The conference was more than happy to oblige the U.S. in this matter, and it unanimously adopted the following resolution:

> Resolved, That the International American Conference recommends the adoption of the metrical decimal system to the nations here represented which have not already adopted it [3].

Since Colombia, Panama, Mexico, Uruguay, Brazil, Chile, Ecuador, Peru, Argentina, Costa Rica and El Salvador had already adopted the system by this time, the U.S. was definitely in the minority on this matter. As a result of this resolution, legislation to make use of the metric system compulsory in U.S. custom houses was drafted and recommended to Congress by Secretaries of the Treasury in their annual reports for 1890, 1891 and 1892, but without success [4].

Aside from the fact that no large-scale efforts were being made to encourage Congress to act on the question of metric adoption, the most likely explanation for the lack of attention to the matter at that time was that both Houses were deeply involved in debating more urgent issues. Indeed, the year 1890 was a most noteworthy one in American politics, both for what occurred during that year and for the impact of those events on the future.

To begin with, two new western States, Idaho and Wyoming, were added to the four which had been admitted to the Union the previous year by a series of "Omnibus Bills." The addition of these western States upset the existing balance of power in Congress, and created a powerful faction in the Senate that favored increasing the use of silver as a basis for underwriting the value of American money. This brought to a head a controversy which had been building up since passage of the Bland-Allison Silver Purchase Act of 1878.

At stake was the question of whether the monetary standard of the U.S. would be based on gold alone or on both gold and silver. Western interests and individuals interested in an international monetary system naturally tended to favor the use of both metals. Traditionalists and those who feared that speculators would manage to bankrupt the U.S. by exchanging silver for gold in tremendous quantities favored a gold standard policy exclusively [5]. The House Committee on Coinage, Weights and Measures was drawn into the middle of this battle because of its jurisdiction over U.S. coins.

The movement favoring the free coinage of silver had grown so strong by 1890 that western Congressmen and Senators were able to secure passage of a more generous silver purchase bill by bargaining with eastern interests. The Sherman Silver Purchase Act was enacted in exchange for the McKinley tariff law, which was designed to further protect the thriving industries of the eastern seaboard by raising the duties on competing foreign goods. The

Sherman Act declared it to be American policy to maintain silver on a parity with gold at a ratio of 16 ounces of silver to 1 ounce of gold, and backed this up by requiring that the Treasury purchase a specified amount of silver each month and issue notes based upon that bullion. The object of all this legislation was to provide a market for the output of western silver mines and to make more money available, especially to farmers. In the short run, the Sherman Act failed to serve this purpose. It did lead people to exchange silver for gold and then hoard the gold, but that was one of the causes of the severe economic depression known as the Panic of 1893 [6]. As a consequence, the Sherman Act was repealed in that year.

As had been true in earlier eras, the Congressional fate of the metric system was linked to concurrent developments in coinage matters during this period. In this case, however, the connection was an indirect one. Because of its involvement in the question of free coinage of silver, the House Committee on Coinage, Weights and Measures was either unable or unwilling to take up the question of metric adoption. In fact, the only printed hearings released by the Committee between January 1890 and December 1891 dealt with silver coins, and they were voluminous [7].

One very obvious reason why the Committee was so interested in this subject between 1891 and 1895 is that it was chaired by Representative Richard "Silver Dick" Bland of Missouri during those years. Bland, cosponsor of the Bland-Allison Act of 1878 and an ardent advocate of bimetallism, had succeeded to this chairmanship when the Democratic Party gained control of the House in 1891. He was a leading contender for his Party's Presidential nomination in the 1896 election, but was beaten by William Jennings Bryan of Nebraska at the convention at which the famous "cross of gold" speech was delivered. Under Bland's leadership, the Committee became divided over the silver question and was unable to successfully sell the notion that bimetallism, both domestic and international, would provide the solution to contemporary monetary problems.

In spite of its preoccupation with more urgent issues, the Congress did take favorable action on several pieces of metric-related legislation between 1893 and 1895. On March 3, 1893, a bill was enacted that established standard gauges (i.e., grades and sizes) for sheet and plate iron and steel [8]. A significant feature of this law was that the standard thicknesses and weights specified for each gauge were given in *both* customary and metric units.

Another act, passed July 12, 1894, established a series of units for electrical measurement. This proposal grew out of the International Electrical Congress held in Chicago in 1893, to which Thomas C. Mendenhall had been an official U.S. delegate. It should not be surprising, then, to find that the units recommended, and established by law, were based solely on the metric system [9].

Dr. Mendenhall was also responsible for another government decision favorable to the metric system. That was the 1893 announcement that the nation's "fundamental standards" would henceforth be metric. From discussions in the previous chapter it will be recalled that President Harrison had received and certified, on January 2, 1890, a set of prototype metric standards as a result of our ratification of the 1875 Treaty of the Meter. On April

5, 1893, Dr. Mendenhall, with the approval of his superior, Treasury Secretary J. G. Carlisle, issued a bulletin declaring these prototypes to be the "fundamental" U.S. standards of length and mass [10]. It is important to note that this was purely an administrative act. Congressional approval was not requested for the so-called "Mendenhall Order," nor was it ever granted after-the-fact. Since authority "to fix the standard of weights and measures" had been given to Congress under the Constitution, the Treasury Department's notice carefully avoided any statements to the effect that the meter and kilogram had been made the "official" or "National" standards of measurement. Instead, the action was carefully justified in the following terms:

"The recent receipt of the very accurate copies of the International Metric Standards . . . enables comparisons to be made directly with those standards, as the equations of the national prototypes are accurately known. It has seemed, therefore, that greater stability in weights and measures, as well as much higher accuracy in their comparison, can be secured by accepting the international prototypes as the fundamental standards of length and mass. It was doubtless the intention of Congress that this should be done when the international metric convention was entered into in 1875; otherwise there would be nothing gained from the annual contributions to its support which the Government has constantly made. Such action will also have the great advantage of putting us in direct relation in our weights and measures with all civilized nations, most of which have adopted the metric system for exclusive use. The practical effect upon our customary weights and measures is, of course, nothing. The most careful study of the relation of the yard and the metre has failed thus far to show that the relation as defined by Congress in the act of 1866 is in error . . .

In view of these facts, and the absence of any material normal standards of customary weights and measures, the Office of Weights and Measures, with the approval of the Secretary of the Treasury, will in the future regard the International Prototype Metre and Kilogramme as fundamental standards and the customary units—the yard and the pound—will be derived therefrom in accordance with the Act of July 28, 1866. Indeed, this course has been practically forced upon this Office for several years, but it is considered desirable to make this formal announcement for the information of all interested in the science of metrology or in measurements of precision [11]."

It is interesting to note that no objection was raised by the Congress when this decision was announced. In fact, in an 1896 report the House Committee on Coinage, Weights and Measures even deplored the lack of Congressional action that had made necessary the executive branch action. They did observe, however, that "This presents a condition of legal complication and practical confusion that ought not to continue [12]." Since neither that Committee nor its successors were able to legally rectify the difficulty, the order was allowed to stand. Indeed, the prototype kilogram number 20 which Dr. Mendenhall declared to be a fundamental standard still serves today as this Nation's reference standard of mass.

Later opponents of the metric system did not, of course, believe that the Treasury Department's action had any validity under the law. Samuel Dale, an outspoken foe of metric advancement, branded this episode as "the Mendenhall conspiracy to discredit English weights and measures," and advanced evidence to show that Dr. Mendenhall had stubbornly refused to cooperate with the British Government in a joint redefinition of customary standards using the metric prototype [13]. Mr. Dale's attack on this order, however, had no bearing on the outcome of legislation between 1890 and 1914 because his charges were not levied until 1927, 3 years after Dr. Mendenhall's death.

In 1894 Dr. Mendenhall left the Coast and Geodetic Survey to assume the Presidency of Worcester Polytechnic Institute, from which he retired in 1901 [14]. During his long career Thomas Mendenhall compiled an amazing record, made all the more outstanding by the fact that he never graduated from college (the Ph. D. degree he carried was an honorary one). In spite of this, he organized physics departments in two universities, served as president of two engineering colleges, was president of the American Association for the Advancement of Science and of the American Metrological Society. He capped all of this by being elected to the National Academy of Sciences. In 1885, while he was connected with the Signal Corps, Dr. Mendenhall devised a scheme for protecting the newly-completed Washington Monument against the recurrence of a lighting attack like the one which had severly damaged it earlier that year. His major contribution to the cause of metric advancement was perhaps the fact that he alone bridged the gap between the earlier campaigns and those which were to come. Having been closely acquainted with Alexander D. Bache and Frederick A. P. Barnard, and thoroughly in agreement with their views on metrological uniformity, Dr. Mendenhall's actions in the early 1890's kept the issue alive until other men came along who were able to pursue it more actively. Even after his health failed he remained an active metric advocate, however, corresponding with and advising the leaders of later metric groups until his death in 1924 at the age of 83.

In the mid-1890's, Dr. Mendenhall's one-man crusade began to bear fruit. In 1893 a bill was introduced,[1] apparently in response to repeated urgings by Treasury Secretaries, to provide for the exclusive use of the metric system in U.S. custom-houses. This bill was never reported on by the Committee on Coinage, Weights and Measures. In 1895, however, a House Resolution was introduced by Mr. Wilson of West Virginia, reported out by the Committee, and passed by the House. The Resolution provided for the appointment of a commission to study and report on the feasibility of adopting the metric system in the United States. The commission was to be made up of the Secretary of the Treasury, the Superintendent of the Coast and Geodetic Survey, and the Director of the Mint. Due to a very unusual error, the mem-

[1] H.R. 2333 (53d Congress).

bers of this commission were not informed of the House action until more than a year after the Resolution's passage on March 2, 1895. The reason for this delay, according to Rep. Charles W. Stone of Pennsylvania, Mr. Bland's successor as chairman of the Committee on Coinage, Weights and Measures, was that the wording of the original House Resolution was changed by the Clerk of the House after passage in such a way that the bill became a Concurrent Resolution, that is, one which would also have required the approval of the Senate before taking effect [15]. The error went undetected because the session of Congress was drawing to a close at that time and because the matter had apparently been successfully disposed of. Consequently no attempt was made to secure any action by the Senate, and the investigation was not ordered. Apparently due to a combination of circumstances, including Mr. Wilson's transfer to the executive branch as newly-elected President McKinley's Postmaster General, the error was not discovered until someone inquired after the overdue report. A belated and superficial set of opinions was then submitted by the responsible officials, but this simple mistake may very well have had a telling effect on the failure of legislation that was soon to come.

A final factor in the revival of Congressional interest in the question of metric adoption at this time was the existence of a strong campaign in Great Britain to change that nation over to the metric system [16].

In spite of persistent and enthusiastic attempts to bring Great Britain into the metric camp, it was still not legal in that nation to use the metric system for most purposes in 1880. At that point, the British advocates may have run out of steam, or perhaps they believed that the U.S. campaign would prove successful, thereby giving them a most powerful argument to use. Whatever the reason, most British activity had come to an end by that year. In 1884 Great Britain ratified the Treaty of the Meter, joined the International Conference of Weights and Measures, and was scheduled to receive prototype metric standards. Even this act did not help to revive British metric interest, however, and the subject lay dormant until several years later. In the meantime, Great Britain, like the U.S., was being upstaged by her neighbors (and commercial competitors) who were changing over to the international system of weights and measures, as the metric system was rapidly coming to be called.

Finally, in 1890, a new organization was founded to do something about the situation. This was the Decimal Association, formed "to promote the adoption of a decimal system of weights, measures, and coinage in the United Kingdom [17]." It soon settled on the metric system as the one to be preferred, and its adoption was given a higher priority than the adoption of decimal coinage [18]. For the first few years of its existence the group was unable to do anything more than collect favorable opinions, resolutions and petitions from trade groups, chambers of commerce, individuals and firms. But this enthusiasm accumlated with time until, in 1895, the Government found it expedient to appoint a Select Committee to investigate the pros and cons of the matter and report to Parliament.

The Committee held sessions during 1895 and took testimony from 14 witnesses. Among them were men on both sides of the question, including the eminent British philosopher Herbert Spencer (who was opposed) and the world reknown scientist Lord Kelvin (who was in favor of metric adoption). On July 1, 1895, the Committee reported to Parliament, recommending:

"(a) That the metric system . . . be at once legalized for all purposes.
(b) That after a lapse of 2 years the metric system be rendered compulsory by Act of Parliament.
(c) That the metric system . . . be taught in all public elementary schools . . . and that decimals be introduced at an earlier period of the school curriculum than is the case at present [19]."

Almost 2 years elapsed before anything occurred as a result of the Committee's recommendations. Finally, on May 27, 1897, the Government sponsored legislation to implement the first recommendation—full legalization. By July 8 of that year the measure had cleared all legislative hurdles and full use of the metric system at last became permissable in the United Kingdom.

The Decimal Association also wanted the other recommendations enacted into law, but achieving this objective was to prove impossible. Nevertheless, they continued to campaign for it in an effort which dragged on for as long a time as the one about to begin in the U.S. The parallel campaigns in the two countries, resulting from the strong ties which had always existed, had a reciprocal effect on participants in both nations. Any real or impending action on one side of the Atlantic was immediately seized on by their counterparts abroad as a compelling reason to settle the issue once and for all by adopting the metric system. Just as the proponents were inclined to buttress each other's efforts, so were the opponents. Before long a British Weights and Measures Association had been organized to oppose any further advance of the metric system, and American metric opponents were among the principal contributors to their literature [20]. Attacking the metric system is a style vaguely reminiscent of Charles Latimer and the International Institute, the Association's simple motto was "Preserve It!" [21]. And preserve they did, at least until 1965.

As will be seen, many American metric actions between 1890 and 1914 were based on events that were happening or supposed to happen soon in Great Britain.

B. A FLEETING VICTORY

One of the most significant events in the entire history of the metric system in the U.S. occurred in 1896. In that year Congress came within an eyelash of approving a measure to adopt the metric system, first for Government affairs and later for the Nation as a whole. Although the House of Representatives first granted and then immediately rescinded its approval of the bill, supporters of the metric system were aroused to further efforts and became even more convinced that the success they had worked so long to attain was near at hand. A new era in the controversy over the metric system had been ushered in.

The times were ripe for it. In the words of the contemporary journalist, Mark Sullivan:

> "In American political history, 1896 was a dividing point. It marked the ending of radicalism arising out of issues associated with currency. For a few years after 1896 there was no political discontent to speak of. . . . It was assuaged by larger supplies of gold from the mines of the world, rising wages and prices, and the accelerated activity of business that came with the war. The political discontent that arose again about 1902 was from different causes, had different issues, and was led by a new spokesman [22]."

The 54th Congress had convened on December 2, 1895, with the Republican Party in control of both the House and the Senate for only the second time since 1873. As a result, the Committee on Coinage, Weights and Measures was now chaired by Representative Charles W. Stone of Pennsylvania. Mr. Stone was by no means as ardent a supporter of free silver as his predecessor, Mr. Bland, had been, and it is more likely that he even opposed the idea. Whatever his views, the election of William McKinley to the Presidency in 1896 sharply curtailed the silver coinage controversy, effectively terminating the Committee's preoccupation with legislation related to it.

Early in the first session of that same Congress, Representative Denis M. Hurley of Brooklyn, New York, introduced a bill "to fix the standard of weights and measures by the adoption of the metric system."[2] The bill further specified that: (1) beginning on July 1, 1897, all Government Departments, in transacting any business requiring the use of weights and measurement, would employ only the metric system; (2) beginning July 1, 1899, the metric system "shall be the only legal system of weights and measures recognized" in the U.S., and (3) the equivalents specified in the Act of 1866 were to be the lawful relationships between metric and customary values.

Mr. Hurley's interest in the metric question, he revealed later, stemmed from the 10 years which he had spent as a weighers' foreman at the New York custom house. "It was while I was thus employed," he said, "using weights and measures everyday, that I saw the want of a better system than the irrational and poorly constructed ones in use. Then, too, I found the French metric system so full of beauty and utility that I have been its warm adherent ever since [23]."

Early in 1896 the House Committee held hearings and compiled testimony related to this bill. Four men, all in favor of the bill were heard in person: Congressmen Hurley and Edward Sauerhering (of Wisconsin), Mr. O. H. Tittman of the Coast and Geodetic Survey, and Professor J. Howard Gore of Columbia University. In addition, many letters and resolutions favorable to the proposal were printed in the record, and the recently-completed British investigation was mentioned at several points. The general line of argument being used by metric supporters had changed little

[2] H.R. 2758; Dec. 26, 1895.

from that of earlier days. The main points they brought up included the long-touted merits inherent in the system—it's uniformity, simplicity, and decimal ratios; the contention that for commercial and scientific dealings it was easier to learn and would save time and increase the accuracy of work; the fact that the U.S. currency system was already decimal; and the estimate that one year of school time for each child would be saved by adopting the metric system. These men were willing to concede that some difficulty would be encountered in making the transition, especially among manufacturers of machinery, but they pointed out that other "civilized" nations had successfully made the change already. In addition, they advanced the argument that the metric system's ultimate adoption by the entire world was a generally-conceded proposition. Only 3 major nations—the U.S., Russia, and Great Britain—had not already done so, and it appeared as though Britain was about to abandon her traditional system in the near future. Under these circumstances, the argument went, it was high time for the U.S. to act on this matter.

The Committee on Coinage, Weights and Measures agreed. On March 16, 1896, Mr. Stone submitted a Report [24] to the House which urged passage of the bill, as amended,[3] in very strong language. The document dealt in turn with the history of U.S. weights and measures (which section was entitled "Existing Confusion"), the advantages of the metric system, and objections to the metric system. Among the findings which the Committee cited as supportive of its recommendations were the following:

Concerning the Status of U.S. Weights and Measures in 1896—"It appears that a legal standard of weight has been established for use in the mint, but that beyond that our weights and measures in ordinary use rest on custom only with indirect legislative recognition; that the metric weights and measures are made legal by direct legislative permission, and that standards of both systems have been equally furnished by the Government to the several States; that the customary system has been adopted by the Treasury Department for use in the custom houses, but that the same Department by formal order has adopted the metric standards as the 'fundamental standards' from which the measures of the customary system shall be derived. This presents a condition of legal complication and practical confusion that ought not to continue. The Constitutional power vested in Congress should be exercised [25]."

"The failure of Congress to establish standards has naturally led each State to do so for itself according to its own whim or caprice, and the diversity is nearly as great as prevailed in feudal times in Europe when each feudal Chieftan thought the exercise of his proper functions of sovereignty required him to establish a distinctive system of his own [26]."

[3] H.R. 7251, March 16, 1896. The effective dates were changed to July 1, 1898 and January 1, 1901, respectively, and a section was added naming the prototype meter and kilogram of the Office of Standard Weights and Measures as the "ultimate" standards.

Concerning the Impact of the Situation on Our Commercial Dealings—"We are out of touch with all the nations of the world commercially except Russia, with which our commerce is small, and England . . . Almost all our entire commerce with the world, then, requires to be translated or converted from the terms our weights and measures into those of the various countries with which we trade [27]."

Concerning Objections to the Difficulty of Changing to the Metric System—"What man has done man can do. What the German, the Austrian, even the Arab and the African have so easily done ought not to frighten or deter the American. . . . A considerable element of our population is made up of immigrants from metric-using nations, who have brought here a practical familiarity with the system . . . [T]he way has been paved for the general adoption of the system to an extent previously done in no other nation. Hence the transition in this Country should be materially easier, than in any other nation that has made it [28]."

"Your committee is not blind to the fact that considerable temporary inconvenience will accompany the change, but they believe that this is greatly overestimated and that it will be of short duration . . . It will be no easier for a hundred million people 10 years hence to make the change than for seventy million today. It is simply a question whether this generation shall accept the annoyance and inconvenience of the change largely for the benefit of the next, or shall we selfishly consult only our own ease and impose on our children the double burden of learning and then discarding the present 'brain-wasting' system. The present generation must meet this test of selfishness or unselfishness, and answer to posterity for duty performed or neglected. The neglect of our fathers cannot justify us. They delayed for a greater light and a clearer way. Passing years have brought the light, and action of other nations has cleared the way [29]."

In a final appeal to their colleagues' higher ideals, the Committee termed the proposed action a matter of "National honor," pointing out that the U.S. ratification of the Treaty of the Meter and our actions at the 1890 International American Conference had both implied an American commitment to use the metric system in order to provide the basis for total international uniformity in weights and measures. "What possible motive can this country have," they asked, "in thus conquetting longer on this subject with the nations of Europe and her Sister republics [30]?"

On the afternoon of April 7, 1896, Mr. Stone was notified that he would have the opportunity to place the bill before the House on that same day [31]. Mr. Stone led off the debate with a speech that followed the lines of his Committee's report and contained all of its essential findings and conclusions [32]. What happened next was reported in the April 24, 1896, issue of *Science:*

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"Mr. Stone's speech was very well received, and it was first thought that a vote would be taken without debate. Mr. Bartlett, of New York, however, secured the floor and made a short speech in opposition to the bill.[4] He was followed by a Representative Otey, of Virginia, who made a humorous speech against the Metric System, dwelling chiefly upon the Metric terms. Mr. Hurley, of Brooklyn, replied in a dignified manner to Mr. Otey's effort and suggested that in the hands of a humorist our present system could be made very ridiculous. After more discussion Mr. Stone called for a vote, and on a division of the House there were 65 votes in the affirmative and 80 in the negative. The vote being less than a quorum, Mr. Stone succeeded in securing an adjournment, and the fight went over until Wednesday morning [April 8], when the yeas and nays were ordered. After the experience of the day before, Mr. Stone was anxious to gain time, believing that it was only necessary to acquaint the members further in regard to the system under more favorable conditions than those of a noisy debate in the House, to secure the passage of the bill; but a vote could not be avoided, and when the announcement was made that the bill had passed by a vote of 119 to 117,[5] a shout of applause went up from the floor and galleries. Those who had opposed the bill, however, took courage, because of the narrow majority in favor of the bill, and promptly moved a reconsideration. Upon this motion yeas and nays were ordered and the opponents of the bill went vigorously to work to change votes, with the bugaboo of the angry farmer protesting against being tangled up with a new system of weights and measures on the eve of a Congressional election. The result of this work was soon apparent. Mr. Hurley's motion to lay the motion to reconsider on the table was lost by a vote of 136 to 111, and the motion to reconsider prevailed by a vote of 141 to 99. Mr. Stone's only remaining chance was to ask to have the bill recommitted to his Committee. This motion was carried *viva voce* [33]."

The primary reason why the bill failed to pass seems to have been that the House was, on the whole, caught by surprise at the appearance of such a proposal. In the debate it was argued that the people didn't understand the metric system, that there was no apparent need to adopt it, or that such sweeping changes as this ought not to be approved without thorough preliminary studies having been made. In this respect the error which had been made in the proceeding Congress that resulted in a delayed and very superficial response to the House Resolution requesting a study may have been a more significant mistake than it appeared to be at the time. It is possible,

[4] Mr. Bartlett implied that a vote for the metric bill was the same as a vote for bimetallism, since both were movements of an international nature.

[5] The vote was actually 119 to 116.

also, that Mr. Stone was not given sufficient time to line up support for his bill before it was brought up on the floor, for the opinion was advanced on several subsequent occasions that people were not opposed to the proposition, they simply did not know enough about it to be in favor of the bill. Considering that the legislation was not defeated outright and that Mr. Stone was allowed to return it to his Committee for further consideration, it may very well have been a lack of adequate advance preparation for the vote which prevented passage of the bill.

Certainly, Mr. Stone and his allies in this campaign did not consider themselves beaten, despite the longstanding precedent of the House of not considering a bill a second time in the same session of Congress after once recommitting it. As the New York trade paper, the *Dry Goods Economist*, reported 10 days after the incident:

"The friends of the bill, so far from being discouraged, have gone to work vigorously. With the new light shed upon the status of the measure by the action of the House they have already made much progress, so that Chairman Stone and Mr. Hurley both feel perfectly confident that the 54th Congress will see the measure enacted into law without material modification of the form in which it was reported.

The canvass which has been begun since the bill was recommitted to the Coinage Committee has already developed the fact that the vote on the bill cannot be taken as a test of the measure in any respect. The opposition which was voiced on the floor was confined to the views of three members, Messrs. Otey, Bartlett and Parker . . . Mr. Bartlett has already withdrawn his opposition and may even consent to vote for the measure when it is called up again, while Mr. Otey had good-naturedly declared that his speech against the bill was intended to be only jocular, and that when the measure comes up he will take it up seriously and address the House in its support.

These surprising gains in strength in the very camp of the opposition are decidedly encouraging to Mr. Stone and his colleagues, but they realize that it will be necessary to make a very careful canvass and a very strong fight in order to secure sufficient support to bring the bill up for consideration as well as to pass it. . . .

[The intention of Congress to adjourn early in view of the approaching elections] does not menace the fate of the Metric System bill even at this session, but it will not be safe to count upon its passage, nor should its friends be at all disheartened in case it is not taken up [34]."

This last admonition was excellent advice in view of what was to occur with respect to this matter.

Mr. Stone was not, in fact, able to secure another opportunity to have the bill considered again in the first session of the 54th Congress. In the following session, however, on February 10, 1897, the Committee on Coinage, Weights and Measures submitted an amended bill and a revised report to the House for its consideration [35].

The amendments to the bill [6] provided for exclusive Government use of the system after July 1, 1900 and legal recognition of it as the U.S. system as of January 1, 1903. In addition, surveys of public lands were exempted from the requirements of the bill, at the Department of the Interior's request, since these surveys would be nearly complete by the time the law took effect and they had not been made using metric measurements [36]. To clarify the intent of the bill on the question of whether or not use of the metric system would be compulsory for the entire Nation, the Committee deleted the word "only" from the phrase: "shall be the only legal system . . . recognized in the United States." The report emphasized that this section was intended to fulfill Congress' obligations under the Constitution, did not make use of the metric system compulsory, and would not prohibit or interfere with the continued use of the customary system by anyone wanting to use it. Rather, the bill would establish legal standards for reference purposes, in case of disputes, that would be the same as those "that are recognized as authoritative by every nation of the civilized world with but two or three exceptions [37]."

The Committee readopted its previous report as being a fair and accurate presentation of the facts and considerations involved. It took the opportunity, however, to reinforce and add to some of its previously-stated reasons why it felt that enactment of this bill was important [38]. The Committee cited petitions it had received from the faculties of 27 colleges in 16 different States and mentioned numerous resolutions from educational, trade and professional associations, all favoring adoption of the metric system. The report also revealed that that Committee had asked the State Department to obtain information on the transition experiences of Germany, Austria, Hungary, Norway and Sweden. The results of this inquiry had led the Committee to the conclusion that:

> "All substantially concur in the statement that the trouble and inconvenience in making the change was by no means serious; that no one of the nations has the least desire to return to the former system; and that the effect on the commerce of the nations adopting the system, so far as any opinion is expressed, has been clearly beneficial [39]."

For these reasons and those it had presented in its earlier report, the Committee again urged passage of the proposed bill, venturing the following prediction:

> "Put the system in practical and uniform operation in the transactions of the Government and the adoption by the people will take care of itself. Its merits will be brought home to them in practical form, and knowledge will inevitably bring approval [40]."

The report and the accompanying legislation never got to the floor for

[6] Still numbered H.R. 7251.

debate and reconsideration, probably because it was released too late in the session to receive clearance from the House leadership. The 54th Congress adjourned less than a month later and the legislation expired with adjournment. What is not clear is the reason why Mr. Stone waited until 2 months of a 3-month session had elapsed before issuing another report. In view of the near success the previous year, and considering the promises of future support that the measure had received, it would have been logical to expect an early Committee report to insure that the amended bill was placed on the agenda for consideration during the second session. Whatever the reason, any momentum that had been built up in regard to this issue was lost by the time the next Congress was convened.

In the meantime, a modest publicity effort had been mounted by the remaining members of the American Metrological Society. In 1896 it issued a booklet, edited by the recording secretary John K. Rees, entitled *The Metric System—Detailed Information as to Laws, Practice, etc.* [41] which was intended to gather support for the Hurley Bill. In addition to extracting the pertinent sections of previous official reports and documents, the Society announced that it was undertaking an ambitious project:

"The American Metrological Society wishes to put up a metric chart in each one of about seventy thousand post-offices in the United States and to circulate for signature among citizens engaged in all kinds of business 100,000 copies of its petition to Congress for the exclusive use of the metric system in the Government bureaus after July 1, 1898, and by the whole people after January 1, 1901. For these purposes $10,000 are wanted; and contributions, however small, are solicited from everybody . . . To every contributor of as much as ten cents, a chart will be sent. The text of the petition is as follows:

The undersigned citizens, residing in his Congressional District, respectfully urge the Honorable Mr. — — — — — to consider favorably and vote for the bill reported to the House of Representatives by the Committee on Coinage, Weights and Measures, to fix the standards of weights and measures by the adoption of the Metric System of weights and measures [42]."

Even though some of these petitions eventually found their way to the Committee, the overall results are unknown. Judging by the outcome of the 1896 legislation, however, the response could not have been as overwhelming or enthusiastic as was anticipated. This was the first time that the mass-petition technique had been applied to achieve support for metric legislation, but it was by no means the last. Metric campaigners on both sides of the question would put great faith in the potential influence of such petitions in later years.

Dr. Mendenhall, who was the president of Worcester Polytechnic Institute and a vice-president of the American Metrological Society by this time, also contributed his share of articles to the literature on the metric system. One such article appeared in *Science,* the journal of the American

Association for the Advancement of Science, and dealt with the broad subject of weights and measures legislation in the context of the recently-rebuffed Hurley Bill [43]. The article was principally historical in its consideration of the subject, but it contained one observation that has weathered the test of time:

> "History shows that marked advances of the character here referred to [i.e., the successful passage of earlier weights and measures laws] are usually brought about through the active, personal interest and enthusiasm of a very few men, often not more than one or two.
>
> . . . [I]t will usually happen that not many members of either House or Senate will have the time or the interest to thoroughly inform themselves of the merits of a measure which does not immediately appeal to them. They depend largely on the few who are well informed, who have made a special study of the subject, and who by reason of their personal character and influence are accepted as authority [44]."

History has also shown, however, that limited interest of this sort has been insufficient to influence the Congress to accept a revision of our entire system of weights and measures. A much broader consensus, which was never achieved, was clearly called for.

Another article by Dr. Mendenhall was triggered by anti-metric arguments that had originally appeared in the London *Times* [45]. While the content of Dr. Mendenhall's reply to letters which had been authored by Herbert Spencer differed little from pro-metric arguments appearing elsewhere, the fact that he felt obliged to respond to them at all illustrates the close connection between contemporary British and American metric activities. Dr. Mendenhall himself acknowledged the relationship in his 13-page article in Appleton's *Popular Science Monthly:*

> "Obstinate conservatism which makes people cling to what is or what has been, merely because it is or has been, . . . is highly developed among English-speaking people on both sides of the Atlantic, and is likely to turn up in the most unexpected places. It is often a phase of ancestral or national pride, and finds its expression in the feeling that whatever pertains to one's own race or country is, on the whole, better than anything else of its kind . . . These people are numerous among opponents of reform in coinage, weights, and measures, and, as already noted, it is with this class that the most serious difficulty is encountered [46]."

Aside from Mr. Spencer, it is not obvious who the men were that Dr. Mendenhall was referring to in his discourse. The opponents of U.S. adoption of the metric system at that time seem to have been quite small in numbers, and they were certainly a lot less active than their predecessors. For example, in all of the hearings held until 1902, not one individual came forth to voice his objections to the Committee on Coinage, Weights and Measures. There was no organized group formed to fight the legislation, and no *anti*-metric petitions were circulated. It may have been that Dr. Mendenhall was simply comparing the British opposition to Charles Latimer and his followers. The International Institute and its philosophy certainly fell within his definition of "obstinate conservatism," and there can be no doubt but that he was well aware of the Institute's earlier activities. But at the time this particular article was written, such opposition in the United States was either nonexistent or dormant. In fact, between 1888 and 1904 only one anti-metric paper appeared in print which was noteworthy, and then only because of its source, not because of its substance or obstinacy.

This lone example of metric opposition was a treatise by George W. Colles, of Boston, which appeared in the 1896 *Transactions* of the American Society of Mechanical Engineers [47]. This Society's members would, in later years, supply some of the keenest opposition to (as well as some ardent support for) the idea of adopting the metric system. Since mechanical engineering was the profession most deeply affected by the proposed change, it was probably inevitable that the practitioners of it should become involved in the controversy through their Society. Mr. Colles' paper was only the first of many heated discussions of the metric question for which this Society provided the forum.

There was very little material of an original nature in Mr. Colles' discussion, but it constituted an excellent review of the anti-metric case (as far as it had developed by 1896). Like others before him, he dwelt extensively upon the historical development of weights and measures, pointing out the 17th and 18th century lack of uniformity that had made the advent of the metric system a welcome development in some European nations. He also presented the history of the English customary system, emphasizing what the British had done to improve their weights and measures that, in his opinion, made their adoption of the metric system unnecessary. Also like others before him, he repeated and gave great credence to the anti-metric portions of John Quincy Adams' report and other earlier opinions unfavorable to the metric system.

Having done this, Mr. Colles' proceeded to list the arguments in favor of metric adoption with an eye to rebutting them in much the same style as had been used by Charles Davies a quarter of a century before. For example, he felt that the argument of uniformity "loses much of its importance when applied to English-speaking nations. Their system is already uniform, and was so, practically, decades before other countries had even considered the subject [48]." In similar fashion he attempted to counter such ideas as the superiority of a decimal system, the improvement represented by the metric system's nomenclature, the claim that not being a metric nation was injuring our foreign trade, and the theory that once people tried the metric system in use that they would gladly discard every other system in favor of it. In all, Mr. Colles drew 24 specific conclusions, all unfavorable, concerning the relative merits of the metric system [49]. For the most part, his objections were based on very practical considerations, such as the legal, political and economic difficulties that would attend such a change. Many of his objections were, in fact, to situations which even metric advocates were often forced to concede the difficulty of overcoming. But Mr. Colles' fears were unnecessary, because the supporters of the idea were not able to get up enough steam on their own accord to conquer the opponent's most powerful ally — inertia.

C. AFTERSHOCKS

When the Committee on Coinage, Weights and Measures failed to obtain consideration of the Hurley Bill a second time, the public's interest in the question of metric adoption subsided. Congress continued to feel strong pressure from within, however, as proposals were advanced and acted upon by the Committee in every year between 1897 and 1901.

On March 19, 1897, 4 days after the convening of the 55th Congress, Mr. Hurley introduced a bill similar to the one which had been hammered out by the Committee in the previous session.[7] This bill also exempted the survey of public lands, but it provided that the metric system would become the legal U.S. system on the same day that the Government adopted it—July 1, 1900. It also omitted the references to the prototype standards and tables of equivalents that, in previous bills, had been included to provide a built-in definition of what was meant by the term "metric system."

Having given much thought to this matter in the previous Congress, and having already submitted two comprehensive reports on it to the House, the Committee was not inclined to hold more hearings or offer new evidence. Instead, the members simply re-affirmed their earlier views in an 1898 report which contained full reprints of those issued previously [50]. Again the Committee's appeal to the House was based not on any urgency or practical necessity for making the change, but on higher principles and a vague promise of some benefits to come in the future:

> "We are today stepping across the threshold of a new national career. The world opens before us. The coming of the new century will find us grasping for the trade and commerce of the world. We are becoming an aggressive force in the affairs of the world. In this new career we will encounter jealous watchfulness and sharp competition. Should we not free ourselves from everything that hampers our activity in the great race? To secure the trade of the nations of the world we must bid for it in terms understood by them. We must carry into the struggle no load of antiquated systems and inconvenient and cumbersome methods [51]."

Those were noble and prophetic thoughts, very well spoken but hardly a compelling reason to adopt another system of weights and measures. The line of reasoning was blunted even more by the fact that American foreign trade had been growing at a furious pace without the benefit of a metric based industry. Between 1888 and 1898, for example, the value of finished

[7] H.R. 1058.

manufactures exported by the U.S. nearly doubled, from $114 million to $223 million [52]. The value of America's total exports in these same years increased from $696 million to $1,231 million, and our trade with Europe, including the United Kingdom, had remained a steady 79 percent of this total amount [53]. Our principal exports at this time were still agricultural products, but even so it was difficult to advance any hard evidence that our competitive position in foreign markets was being undermined by the fact that we had not adopted the metric system. This argument was to prove to be even less credible in future years.

Whether it was for this reason or whether it was because the Congress was engaged in such other affairs as the Spanish-American War and the aggresive pursuit of foreign influence, is immaterial. The end result was that the metric system proposal once again failed to clear the necessary procedural hurdles and was not considered.

In the 56th Congress, which met between December 1889 and March 1901, the metric adoption issue was raised again, but by this time it had become necessary to find new people to support the proposal. Congressman Hurley had died in February 1899 and Chairman Stone had been defeated in his bid for reelection. Three individuals came forward to replace these men as Congressional champions of metric system proposals: Representatives James H. Southard of Ohio, Lucius N. Littauer of New York, and John F. Shafroth of Colorado. Mr. Southard had replaced Charles Stone as Chairman of the Committee on Coinage, Weights and Measures, and, under his leadership, the Committee would devote more of its time to metric legislation than at any other period in its history. Mr. Littauer was a wealthy glove manufacturer, financier and philanthropist who was to sponsor and otherwise support several pieces of metric legislation during the 10 years he served in Congress [54]. Mr. Shafroth was a veteran free silver campaigner and he was also to become one of the most ardent advocates of the metric system in Congress [55].

Early in the first session of the 56th Congress, both Mr. Littauer and Mr. Shafroth introduced metric bills.[8] These two bills were very similar to each other and both were very much like the abbreviated bill Mr. Hurley had proposed in 1897. The Committee on Coinage, Weights and Measures chose to review and report on Mr. Shafroth's bill, recommending passage with only minor changes suggested. Under this proposal the metric system would become the "legal standard weights and measures of and in the United States," and would be required for use in Government business as of January 1, 1903.

The Committee's report on the bill was brief but noteworthy [56]. Reiterating its belief that there were "obvious advantages" to be gained by adopting the metric system, the Committee declined to add further to the number of "voluminous reports" already in existence [57]. Instead of emphasizing the potential economic advantages of metric adoption, however, the Committee seized upon the argument that less time and intellectual effort were required to use the metric system than the customary system of

[8] H.R. 104 (Mr. Littauer), Dec. 4, 1899; and H.R. 5768 (Mr. Shafroth), Jan. 10, 1900.

weights and measures. In support of this contention the Committee reprinted, verbatim, a document issued by the American Metrological Society [58]. The line of reasoning behind this argument was approximately as follows:

1. Because of its basic simplicity, small number of fundamental units, and logical method for deriving multiples and sub-units, the metric system offered economy in the time and intellectual energy required to understand and use weights and measures.
2. Time would be saved in learning the metric system as compared to learning the customary system because:

   "No one can easily forget his youthful attempts to memorize long and generally almost meaningless tables and to master the mysteries of addition, subtraction, multiplication, and division of 'compound numbers' . . . Conservative educators have estimated that the use of the metric system . . . would save one to two years of the school life of every child [59]."

3. Use of a decimal system of weights and measures would vastly reduce the probability of error in calculations and in all other practical applications of weights and measures. To demonstrate the importance of this aspect, the American Metrological society hinted that mistakes were being made in filling medical prescriptions that were likely to be fatal in many instances.

In the end, this approach to convincing the House that adoption of the metric system urgently required its attention worked no better than the Committee's previous arguments. The proposed legislation never reached the floor and expired with the adjournment of Congress.

Two days after the above report had been issued, however, another bill which the Committee on Coinage, Weights and Measures had sponsored was enacted into law. This was the bill creating the National Bureau of Standards.

D. ESTABLISHMENT OF THE NATIONAL BUREAU OF STANDARDS

Until about 1900, America's involvement with science had been principally on an individual basis. With the turn of the century, that situation began to change. As Mark Sullivan informs us:

"The one conspicuous lack in the schools of 1865-1895 was Science . . .

The lack of Science teaching in the schools would have justified, if anything would, Henry Adams's complaint of ill-equipment for life in the 20th century. The schoolboy of the 1880's was destined to spend his mature life in a world in which science and its applications affected his existence vitally, but the common schools taught him not even the elementary facts of physics and chemistry. He was destined to see the automobile substituted for the horse; to see electricity take the place of his former means of heat and power; to have daily familiarity with the telephone and radio, to come in contact with the laws of refraction as expressed in the camera, to see the X-ray and radium in the hands of his doctor; to see chemistry, by the devising of rayon and other products, flout one of the most infallible maxims in his school books: 'you cannot make a silk-purse out of a sow's ear [60].' "

Many scientists foresaw that the Nation was not prepared to meet fully the technical needs of such a world. In particular, the country lacked a central institution responsible for measurement standards, precision instrument development, and materials research. Following the example set by other countries in such matters, the Secretary of the Treasury was persuaded to propose the creation of a new governmental institution, "a complete laboratory, fitted for undertaking the most refined measurements known to modern science [61]." The plan was to enlarge upon the duties and functions of the Office of Standard Weights and Measures in order to establish the new institution, which was to be called the "National Standardizing Bureau [62]."

This plan had not sprung up overnight. According to historian Rexmond C. Cochrane, a Federal standards laboratory had been talked about for nearly 20 years, but the actual drawing up of plans for one had been awaiting the coincidence of the right man and the right time [63]. Treasury Secretary Lyman J. Gage, a Chicago banker, proved to be the eventual matchmaker. In the summer of 1899 he gave to his Assistant Secretary, Frank A. Vanderlip, the job of finding someone to investigate and report on the situation with respect to the need for a national standards laboratory and to propose appropriate legislation.

Mr. Vanderlip settled on a former college classmate, Samuel W. Stratton, who was then a professor of physics at the University of Chicago. Secretary Gage brought Stratton to Washington as "Inspector of Standards" and promptly set him to work organizing the proposal for the creation of the new institution.

Stratton did his work well. Not only was he able to construct a convincing case for the necessity of a national standards laboratory, but he was also able to obtain an impressive display of support for the measure from the most prestigious scientific and educational organizations in the country.

The results of his work are contained in a letter to the Speaker of the House from Secretary Gage dated April 18, 1900 [64]. Among the more important conditions listed as necessitating the establishment of the proposed agency were:

(1) "[T]he increased order of accuracy demanded in scientific and commercial measurements and the exceedingly rapid progress of pure and applied science [65]." These required a modern laboratory in which to undertake the development and improvement of standards.

(2) The fact that Germany, Austria, Russia and, most recently, England had all established government-operated standards institutions.

(3) The rapid rate at which "institutions of learning, laboratories, observatories, and scientific societies" were being established or were growing.
(4) The fact that such practical problems as measuring the temperature in furnaces and metering the amount of electricity generated and sold required far greater accuracy than ever before because enormous sums of money were at stake.
(5) The rapid growth rate of American companies which manufactured scientific apparatus and precision instruments, a class of products which had previously been available only from foreign manufacturers.
(6) The need to provide schools, factories and other institutions in new territories recently acquired by the United States with standards and measuring equipment.

The Committee on Coinage, Weights and Measures, at least, was convinced. Less than a month later, on May 14, 1900, Chairman Southard sent the proposed legislation,[9] to the floor with the unanimous approval of the Committee. On that same day, the bill was introduced in the Senate.[10] Nothing further occurred until December 1900, when a Subcommittee of the Committee on Commerce held hearings on the bill and then issued its report. After resolving a few differences of opinion between the House and the Senate having to do with the funds to be appropriated for the new bureau and the salary of its director, the bill was debated on the floor of the House on March 2, 1901. The following day, March 3, 1901, the bill was enacted into law. It created, as of July 1, a National Bureau of Standards which was to have the following functions:

"[T]he custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with *the standards adopted or recognized by the Government;*[11] the construction when necessary of standards, their multiples, and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants, and the properties of materials when such data are of great importance to science or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere [66]."

Appropriately, President McKinley appointed Dr. Stratton to be the first director of the new National Bureau of Standards.[12]

Samuel Wesley Stratton would serve in this post for more than 21 years, making NBS his principal life's work. Born on a farm near Litchfield, Illinois

[9] H.R. 11350.
[10] S. 4680.
[11] Emphasis supplied.
[12] Hereafter referred to as NBS or simply "the Bureau."

in 1861 he became interested in machinery and the "mechanic arts" at an early age [67]. From 1880 to 1884 he studied mechanical engineering at the Illinois Industrial University (now the University of Illinois), working at a variety of tasks to pay for his education. After graduation Stratton stayed on at the University to teach, eventually attaining the rank of professor of physics and electrical engineering. In 1892 he was offered, and accepted, a position at the new University of Chicago. During his tenure there Stratton served under the reknowned physicist (and eventual Nobel Prize winner) Albert A. Michelson, from whom he learned a great deal about the science of measurement and precision instrumentation. Upon the outbreak of the Spanish-American War, Stratton was commissioned a lieutenant in the U.S. Navy, serving in a variety of administrative posts during his 8 months of service. Shortly after his discharge from the Navy, he received his invitation from Secretary Gage to come to Washington. His career at the National Bureau of Standards lasted from 1901 until January 1, 1923, when he became the president of the Massachusetts Institute of Technology. Dr. Stratton never married but he had a very active social life and a wide circle of acquaintances that reads like a Who's Who of the early part of the 20th century—Herbert Hoover, Thomas Edison, and Alexander Graham Bell to mention only a few. He died on October 18, 1931, while dictating a tribute to Thomas Edison, whose death had occurred that same morning.

How rapidly the new Bureau was organized,[13] and began fulfilling its functions was demonstrated in a 1905 report authored by Dr. Stratton and his chief physicist, Edward B. Rosa [68]. The first concern had been the planning and construction of a permanent home for the laboratory. A 7.5 acre site in northwest Washington, D.C. had been selected and by 1905 two buildings had already been erected, a third one was nearly completed, and a fourth one was in the planning stage. The personnel of the Bureau, which had numbered 14 the first year, had been increased to 87, over 75 percent of which were scientific and technical men. The scientific work of the Bureau was carried out in organizational units whose names were descriptive of the nature of their work: weights and measures, heat and thermometry, light and optical instruments, electrical measuring instruments, chemistry, and so on. The actual work itself was highly technical in substance, as indicated by examples of the work cited as being in progress or recently completed:

> "An extended research on the ratio of the electromagnetic and electrostatic units employing three different types of standard condensers [has been completed] . . .
>
> The Bureau has a carefully constructed absolute standard of inductance the value of which is accurately known by calculation. We shall measure its value very accurately [using two methods]. This will give two new determinations of the ohm in absolute measure . . .

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[13] In 1903 the Bureau was transferred from the Treasury Department to the newly-created Department of Commerce and Labor and its name was shortened to "U.S. Bureau of Standards." When the Department was reorganized in 1913 the Bureau remained with the Department of Commerce segment. The original name was restored in 1934.

An equipment for life tests is being installed, for use in the testing of lamps for the departments of the government and for seasoning standards . . .

Samples of a few important materials, including limestone and steel, have been carefully analyzed with a view to their distribution when necessary for the purpose of checking the accuracy of methods of analysis used in scientific work and the industries [69]."

In all, it was reported, the Bureau had performed 16,680 tests and calibrations between July 1, 1904 and July 1, 1905, and had issued 26 bulletins, 10 circulars and a number of miscellaneous publications, including tables of equivalents of customary and metric weights and measures and a chart entitled "The International Metric System."

Another NBS undertaking that was to prove significant to the history of the metric system in the U.S. was described in the following terms:

"Last January a meeting of the state sealers of weights and measures was held at the bureau for the purpose of discussing the means for securing uniform laws and inspection of commercial weights and measures throughout the United States. A compilation of the various state laws on the subject showed the greatest diversity. The efforts of the bureau will be toward uniform laws and practices in matters pertaining to weights and measures [70]."

Eventually this meeting would become an annual affair and it would result in the creation of a formal organization — the National Conference on Weights and Measures, which is still a functioning and vital organization today. It was this particular Bureau activity which the opponents of metric adoption attacked as being an attempt to lobby for favorable metric action from Congress. Although the Conference's deliberations have generally centered on technical solutions to very practical weights and measures problems, the opponents viewed it as a Government-sponsored pro-metric society. For creating this alleged lobby, they blamed the Bureau, its director, and its supporters in Congress.

In this connection it is interesting to note that even though two metric bills were pending before the Committee on Coinage, Weights and Measures at the same time as the bill to establish NBS, there were very few references to the metric question in the hearings on NBS, and Dr. Stratton's position with respect to it apparently played no part in the final decision. The same was true in the Senate. Questions were raised, of course, about the legal status and scientific adequacy of the Government's standards, but none of the witnesses was asked whether or not he favored general U.S. adoption of the metric system. In fact, the question seems to have been carefully avoided, the proposed legislation referring only to "the standards adopted or recognized by the Government." It is possible that there was a tacit understanding among the participants in the discussion that the two issues were not to be intermingled, and later metric opponents alleged that such was the case. There is no firm evidence to support that contention, however, despite the fact that Dr. Stratton came out squarely in favor of the metric system in subsequent hearings. Although all of this give-and-take was still in the future in 1901, the history of the metric system in the U.S. had been irrevocably linked to the National Bureau of Standards by the very act of that institution's creation, as would become evident many times in subsequent years.

E. 1902: THE YEAR OF TRANSITION

Between 1888 and 1902 the basic assumption that adoption of the metric system was inevitable and advantageous had gone largely unchallenged. It was true that Congress had never been able to legislate an exact date for the changeover to occur, but most participants in the debate had agreed that, sooner or later, it would have to happen. Beginning in 1902, however, a chorus of dissent arose that was to grow ever louder as time passed.

Once again the Committee on Coinage, Weights and Measures supplied the forum for the debate when it decided to hold hearings on proposed metric legislation. Two bills were submitted for consideration,[14] early in the 57th Congress by the same Representatives that had sponsored the last measures—Mr. Shafroth and Mr. Littauer. With the exception of the effective dates, both bills were nearly identical to each other and neither one was significantly different from those of the preceeding few years. Whereas Mr. Littauer's bill would have taken effect for all purposes on July 1, 1902, however, Mr. Shafroth's proposal was more generous. It provided for Government use as of January 1, 1903 and for making the metric system "the legal standard weights and measures of and in the United States" on January 1, 1904.

Between February 6 and March 6, 1902, the Committee held hearings on the subject. The opening words of the Chairman, Mr. Southard, gave an indication that these hearings were not to be a mere repeat performance by earlier witnesses:

"Our purpose has been and is to get the views of the men of the country who have to do with the application of weights and measures to the business of the country. In the consideration of bills heretofore we have confined ourselves very largely to professional men. Although their opinion is good and reliable, still we want to hear from the manufacturers and business men of the country as well . . . [71]."

This objective was achieved. In all, 29 witnesses appeared before the Committee on this occasion and 11 of these were representing private industry. To be sure, most of these men were qualified engineers (as distinct from businessmen without technical backgrounds) but they were speaking on behalf of their firms rather than on behalf of their professions. Among them were such well-known individuals as John A. Brashear, an eminent astronomical and optical instrument maker; Arthur E. Kennelly, a successful

[14] H.R. 123 (Mr. Shafroth); December 2, 1901, and H.R. 2054 (Mr. Littauer); December 3, 1901.

consultant on electrical engineering matters; Walter M. McFarland, acting vice-president of the Westinghouse Electric and Manufacturing Company; and Henry Troemner, a manufacturer of balances and scales. The "professional men" referred to by Mr. Southard were also in attendance in force, most of them by virtue of their connection with the Federal Government. Dr. Stratton was among them. In addition to the witnesses who appeared in person, statements were submitted from about a dozen individuals who had been invited to address the Committee but who were unable to do so, and a number of resolutions favorable to the bill were received from various organizations. All of these opinions and statements were entered into the official record of the hearings.

For the most part, the 1902 hearings reveal very little change of attitude on the part of professional men, especially Government-employed ones, toward the question of metric adoption. The following extracts from the statement of several such people are illustrative of this fact:

"As far as our bureau is concerned, the Coast and Geodetic Survey, I wish to say we are in worse case than any other bureau under the Government because we have to deal with charts, soundings, etc., on which we show fathoms and feet, and I think our charts could be much simplified if we had only one system; . . . it would be a great advantage if the metric system could be adopted [72]." (Mr. O. H. Tittman, Superintendent of the Coast and Geodetic Survey.)

"In 1894 I issued a circular letter to the medical officers of the Army requiring that the metric system should be used after a date which was 6 months ahead of the time fixed in the issuance of the order. I gave them 6 months' time to get ready. After that, all prescriptions were to be written according to the metric system . . . . [I]t has been successfully used [since then], and I see no reason why it should not be required of officers in other branches of the Government service. That will certainly be the best possible way to introduce it to the people generally and make them familiar with it [73]. . . (Gen. G. M. Sternberg, Surgeon-General, United States Army.)

"The electrical engineer has greater difficulty in carrying out the ordinary routine work of his business by reason of not having the simplicity of the metric system in his professional work, and from his having to adopt this complex system which is in vogue . . . . Not only would the general adoption of the metric system be a great boon for electrical engineers as engineers, but it would be a great boon to them as members of the general public [74]." (Dr. A. E. Kennelly, electrical engineer, of Philadelphia.)

"When it came to putting a standard of measurement into my own business I confess I was prejudiced in favor of the old English system . . . Not long after I went into the business of making astronomical and astrophysical instruments, I found the orders that I was receiving came largely from foreign nations in metric

> dimensions . . . I then ordered in my own shop metric rules, metric gauges, and the adoption of the metric system of measurements, tables, etc., wherever they could be used . . . Unfortunately we get orders from the United States Naval Observatory in the English measure and from the Smithsonian Institution and the Coast Survey in the French measure, and I must please the directors of these institutions of the Government. The workmen find it easy to work in the metric system. I like it, it is beautiful because of the transposition features from the meter to the decimeter and the centimeter and the millimeter, and so on [75]." (Mr. John A. Brashear, instrument maker, Allegheny, Pa.)

At this same hearing, director Stratton of the National Bureau of Standards made his first public statement concerning adoption of the metric system. In it he declared himself to be an advocate of the proposition. In spite of the fact that he had doubtless been busy attending to the details of organizing, staffing and housing the new laboratory, he had obviously found time to interest himself in this subject. The testimony contained ample evidence that Dr. Stratton had taken the trouble to thoroughly acquaint himself with the earlier background of the subject and to arm himself with ammunition suitable for countering the objections of those who were opposed to the metric system. He also made statements that probably led these same opponents to conclude that the National Conference on Weights and Measures was created by Stratton to apply pressure on the Congress to adopt the metric system. From his testimony it was evident why some people came to believe that anti-metric views would not get a fair hearing from officials at the National Bureau of Standards.

This opinion could only have been reinforced by Chairman Southard's implication that Dr. Stratton had assisted the Committee in organizing the hearings: "I know the diligence he has exercised," he stated, "in reaching a number of men of the country, and I know he is, perhaps, the best qualified of anybody to speak on the subject [76]." As most of the witnesses at the hearing were inclined to favor metric adoption, it was natural to suspect Dr. Stratton of exerting an undue influence in this direction. Another factor which undoubtedly added to the mistrust placed in this entire process was the fact that Dr. Stratton was allowed to be present at all eight half-day sessions at which testimony was taken, and that he was even permitted by the Committee to question some of the witnesses who appeared. By doing this, the Committee indicated to the metric system's opponents that they would rely heavily on Dr. Stratton's technical knowledge and on his expert judgment in arriving at their final conclusions. As Dr. Stratton avowed himself to be an adherent of the system, it is small wonder that the opponents of the measure became upset over the situation.

Unfortunately, there is no way of ascertaining how much effort Dr. Stratton actually devoted to attempting to secure a metric adoption bill in 1902 and over the next few years. Whether, as the opponents claimed, he abused a public trust and misused the official position of NBS to achieve these ends

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is doubtful. Such details of the opponents' case as remain are based on circumstantial evidence, loosely interpreted, and Dr. Stratton vehemently denied such charges at the time they were made. At any rate, had these allegations been true, even though they had not been made public at the time, it is unlikely that Dr. Stratton would have advertised his intentions so openly by playing a prominent part at the hearings.

Whatever the truth of this matter, Dr. Stratton went into the 1902 hearings as a respected official who had not publicly committed himself on the question of metric adoption. The good relationships which he had developed with the committee members and his own self-confidence permitted him to state his views frankly and emphatically, at least on this one occasion. The following extracts from his 1902 testimony represent what were probably his true feelings for the rest of his life, although he was never again able to afford the luxury of such openness.

After beginning his statement with a review of the historical development of American weights and measures, Dr. Stratton elected to discuss the arguments of those opposing the change:

"Certain objections have from time to time been raised in opposition to the adoption of the metric system, but the experience of other countries and of our own has shown that many of these objections are without foundation. Let us take for example the most serious objection of all, which is that we have learned to think in the old system of weights and measures. Manufacturers, mechanics, tradesmen, consumers, and in fact all classes of people have learned to think in the old system of weights and measures. They have acquired experience as to sizes, quantities, and relations, and this experience is daily used in new business, new designs, and new relations. These mental comparisons are never exact measurements, but none the less important . . . Fortunately in this case, the difficulty is not nearly as great as those who are unfamiliar with the metric system would have us believe. There are in all cases simple approximate ratios which will lighten the burdens of the transition stage . . . In a comparatively short time people would learn to think in the new system. The importance of these simple approximate relations cannot be overestimated, since they will prove of great assistance in the translation of our past experience in the common system to our future needs in the metric system.

We must, I think, give all classes of people the credit for having a certain amount of intelligence and common sense, and in no country is the average degree of intelligence of the people so high as in this country today [77]."

"Next in importance comes the expense involved in making the change, and I am sorry to say that this has in some cases been grossly exaggerated, and by those who have failed to consider only such changes as are absolutely necessary and involved in the legislation proposed.

It seems to me that manufacturers may be divided into two classes, those who manufacture a product in the form of material and supplies, such as cloth, paper, metal rods, plates, sheets, tubing, wires, and many other articles, and those who construct machines for doing a certain thing, or turning out a certain product. Now, in the shop of the first kind . . . all that would ever be required is that its product be made to metric dimensions when desired . . .

In the second place, . . . the manufacturer of a machine need only alter that machine in such a manner that its product may be turned out in metric dimensions [78]."

"It has been claimed that the metric system is not a binary system, and this has been offered as an objection to it. The metric system is just as much of a binary system as any other if we choose to use it so. In dealing with the common affairs of life we often find it convenient to speak of halves and quarters. This we may still do in the metric system and retain the advantages of a decimal system, with the further advantage that the moment these dimensions enter into computations they are expressed as decimals without any inconvenience, 1/2 becoming 0.5 and 1/4 becoming 0.25. It matters not whether we speak of a quarter of a dollar or 25 cents [79]."

From this testimony it can be seen that the general nature of the arguments for and against the metric system had not changed substantially from the time of John Quincy Adams. All that was required was that they be modernized from time to time to keep pace with advancing technology.

For his next subject of discussion, Dr. Stratton chose to single out the existing situation with respect to State weights and measures laws and practices. Three years later Dr. Stratton would undertake to organize the previously-mentioned National Conference on Weights and Measures in response to the conditions noted in this statement. He would also be attacked for doing so. In this respect it is perhaps unfortunate that he selected a hearing that dealt with the metric system to illustrate the need for cooperating with the States, because these two efforts would ever after be intimately linked together as far as opponents of the metric system were concerned. Had Dr. Stratton chosen some other forum in which to unveil his plans, life might have been more pleasant for him in subsequent years. On the other hand, it may be that there *was* some relationship between Dr. Stratton's advocacy of the metric system and the founding of the Conference.

Irrespective of the motivation behind the Conference, the problems described in the 1902 hearings were very real ones and were objects of legitimate concern to NBS under its legislative charter:

"Investigations as to the laws and regulations throughout the country concerning weights and measures have developed the fact that the whole subject of weights and measures, that is to say, those in common use by the people, are in a chaotic condition. In some of our largest cities no provision is made for the inspection and regulation of weights and measures; in others the facilities are obsolete or entirely inadequate. This is largely due to the fact that there has been no central place to which State and city officials having such matters in charge might go for standards and instructions regarding their use. Scarcely a day passes that the Bureau of Standards does not receive a request for information looking forward to a better condition of weights and measures used in the common affairs of life. State and city sealers have asked for specifications as to what standards and apparatus should be procured in order that such matters might be properly handled in the district they represent.

This is one of the greatest opportunities to do good that has come to the Bureau of Standards. Shall we advise these men to put in a complete outfit of the many standards in the common system, or shall we advise the new? The standards and apparatus on hand will probably answer for the transition period. But if the metric system is to come it would certainly be unwise to advise these officials to procure a complete outfit in the old system. State and city officials have, without exception, expressed themselves as in favor of the new [80]."

Dr. Stratton's testimony also indicated that he was very well versed as to what was occuring on the other side of the Atlantic and that he attached great importance to it. He first discussed the 1895 hearings and report of the Select Committee of the House of Commons, noting that "It is conceded by those who are in a position to know that the adoption of the metric system by either Great Britain and the United States will cause the other to follow at once. Shall we not take the lead [81]?" He next passed on to the Committee on Coinage, Weights and Measures a bit of information that would be repeated many times in subsequent months. "Over 200 members of Parliament," he announced, "have pledged themselves to vote for the compulsory adoption of the metric system [82]." He followed this up with a lengthy list of British organizations and individuals that had declared their support for the proposition. This list had most likely been supplied to Dr. Stratton by the Decimal Association, since it corresponds with the content of that organization's contemporary literature.

In concluding his testimony, Dr. Stratton summarized his views in the following words:

"The absolute necessity for an international system of weights and measures and the great advantage to be gained thereby are today admitted even by the most conservative. That such a system is inevitable in the near future is also admitted by everyone familiar with the rapid spread of the use of the metric system of weights and measures and who are broad enough to differentiate public from private interests and frank enough to admit the facts. There is not the slightest possibility of our own system, full of inconsistent ratios, inelastic and unsuitable for many purposes, with the same name for different units, ever becoming universal. The question is at present, then, not so much as to the desirability of an international system, nor what that system shall be, for these are questions which have practically been settled at the present time. The problem to be solved is how this change in weights and measures can be brought about with the least confusion and inconvenience to all concerned. It is evident that the inconvenience, expense, and confusion which necessarily attend such a change will not be lessened with time, but on the contrary will be the more difficult the longer it is postponed [83]."

And so, the American supporters of metric adoption, with director Stratton of the National Bureau of Standards in the vanguard, had received another day in court. Their basic premises had changed little over the years despite the fact that such arguments had not yet met with success. Still, up until now, they had encountered only limited resistance to the proposed reform and had managed to secure favorable recommendations from the Committee in four successive Congresses. For the supporters, diligent persistence had become the name of the game.

At this same set of hearings on the 1902 metric bills, however, the first real opposition to the proposal since 1888 was voiced. The objections came from two different sources: Government officials whose operations would be adversely affected if the bill became law; and a small number of manufacturers who saw the entire scheme as a threat to their freedom of enterprise.

Among Government officials, the objections came from many of the same bureaus who had doubted the efficacy of the change when surveyed more than 20 years before. This fact, however, did not make their objections any less real or less important in 1902. To a man, they did not fault the metric system for any inherent disadvantages; indeed they were willing to grant its superior attributes for certain applications. Rather, they were worried about the transition period—the time allowed for the change, the expense involved, and the impact on the efficiency of their operations. For example:

"[A]s customs officers throughout the United States we have to deal with this so-called tariff act of July 24, 1897 [the Dingley tariff]. If you refer to that tariff act you will find the units pounds, square yards, tons, and feet. Now, if you enact this bill it is necessarily going to cause confusion unless you amend your tariff bill to accord with your present bill . . . As a general proposition, I think it is a good one, but in doing it you must be careful that you do not disturb other laws which are equally important as this one [84]." (Mr. H. E. Esterbrook, U.S. Customs Service.)

"[I]t would be very embarrassing to the internal-revenue system to adopt the metric system before the gauging officers receive further and special education in this system, such as might be acquired through its adoption in commercial and manufacturing circles. If the manufacturers of tobacco, and the distillers, and the brewers should adopt the metric system Congress would naturally impose taxes upon articles measured in the same way . . . The metric system, like the United States system of coinage, inasmuch as it practically eliminates the use of all fractions except decimal fractions, is much to be commended. Its use, however, in the United States Internal Revenue Service, under other existing systems used in the business of the country, seems to be impracticable [85]." (Mr. C. A. Bates, Head of Assessment Division, Internal Revenue Service.)

"As regards the metric system, Mr. Chairman, it is, to my idea an ideal system for the laboratory or for the academy. Practically, at the present day, its adoption would cause a great deal of confusion in the naval machine shops and in naval contracts, with regard to bolts and nuts, the diameters of bolts and all that sort of work. It would also cause considerable confusion in our drafting rooms [86]." (Rear Admiral George W. Melville, Chief of the Bureau of Steam Engineering, Navy Department.)

The representatives of private industry who informed the Committee that they were opposed to metric adoption also advanced very practical reasons for their stand, many similar to those advanced by Government officials:

"I . . . felt it was necessary to talk the matter over with our own experts, our engineers and our superintendents, the people who would actually have handled it and who would be most affected by the change, and I found on talking the matter over with them that they were by no means favorable to the change; . . . as far as our company is concerned, and with respect to the class of work in which we are engaged, there would be no particular advantage in making the change. It would be a very great expense and cause very great annoyance, and on the whole would be a decided disadvantage, so that as far as we are concerned, looking at it as a plain business proposition, whether it is desirable or not for us to agree to the change, we do not feel that our interests would be subserved by the change [87]." (Mr. Walter M. McFarland, Acting Vice-President, Westinghouse Electric and Manufacturing Company.)

Similar statements came from Mr. George M. Bond of the Pratt and Whitney Company of Hartford, Connecticut and Mr. Henry D. Sharpe of the Brown and Sharpe Manufacturing Company of Providence, Rhode Island.[15]

An important aspect of the opposition expressed at this time, and maybe the most significant factor in the subsequent growth of it, was the way in which Committee members reacted to it. Many of them apparently were surprised at hearing opposition voiced, while others seemed to be skeptical about the validity of the arguments. Consider, for instance, the following

[15] Mr. Sharpe conveyed his views in a letter to the Committee, not in person.

exchange between Mr. McFarland, Chairman Southard and Representative Shafroth:

"The CHAIRMAN . . . . I do not understand why it is necessary for you to change a single machine, to change a single part of a single machine and change the drawings for any part of any machine. If there is any reason for that, I would like to hear it?

Mr. McFarland . . . . I have stated it before.

The CHAIRMAN . . . . It may be I am obtuse.

Mr. McFarland . . . . I am apparently not able to present the point so as to have you gentlemen apprehend the force of it. The point I made was that in all manufacturing the strong tendency is to manufacture to exact multiples, not odd fractions, and that this very tendency would compel you to shift over and change your drawings so that you would have the exact metric dimensions for those things instead of odd decimals of a millimeter, which itself is a very small measure.

Mr. Shafroth . . . . Does not that come up in the form of new machines and not as the old machines?

Mr. McFarland . . . . But do you not see what comes up? . . . . Even if [a manufacturer] goes to the new system he has to retain the old system for a long time in part of the works, so as to be able to make the old standard sizes for repair parts.

Mr. Shafroth . . . .They can keep quantities of stock on hand for that, can they not?

Mr. McFarland . . . . You can not lock up capital in that way, and of course you can not make an estimate of how long these things are going to be demanded.

Mr. Shafroth . . . . According to your theory, if a nation adopts a system of some kind, no matter how bad it is, it is better to keep it than to go to a new [88]."

In addition to the February-March hearings, a supplemental hearing was conducted on April 24, 1902. This date was after the Committee had issued its report on the pending bills, so it did not figure in the decision. It complemented the Committee's recommendations, however, and was called to take advantage of a special opportunity. That was the opportunity to hear the views of Lord Kelvin—one of the foremost scientists in the world—on the question of metric adoption. Lord Kelvin's position with respect to this issue was already well known because he had been a leading advocate of British metric adoption for years. Nevertheless, the Committee on Coinage, Weights and Measures was pleased to hear the opinions of so eminent a man as Lord Kelvin. Quite naturally, Lord Kelvin stressed the progress being made in England and the relationship of that campaign to the one in progress in the U.S.:

"I am sorry that we are not so far advanced as we would like to be. We will find it coming suddenly in England, and while, with local patriotism for England, I would rather that England should do

> it first and America should follow, yet I would very much prefer that America should lead if the end can so be accomplished sooner. *And if America decides to make this reform England will follow very quickly.* I believe that . . . England will see an argument which will be sufficient to overcome all residual sluggishness [89]."

At his appearance before the Committee, Lord Kelvin was accompanied by Mr. George Westinghouse, founder of the Westinghouse Electric and Manufacturing Company, who expressed the opinion that: "Nothing but good could come from the passage of the bill [90]." Because this position was inconsistent with that of Mr. McFarland, who had represented the company at the earlier hearing, Mr. Westinghouse was asked if he had read Mr. McFarland's statement. To this, he replied that he had read a newspaper account of it and defended Mr. McFarland's judgment:

> "He came here to give you the best impression he could with a prejudice in favor of the metric system. But when we talked it over with all our men, and went into the thing very carefully, they found that to make the change from the English measurement at once would be a hardship to many manufacturers [91]."

As already noted, these statements came too late to effect the Committee's recommendation, but they pointed up the fact that public opinion on the question of metric adoption was beginning to diverge again after more than a decade of relatively smooth sailing.

The report of the Committee, submitted to the House on April 21, 1902, followed the general pattern of its predecessors [92]. For at least the eighth time, the Committee reviewed the historical development of the issue, emphasizing the events which had occurred since 1889. Next the Committee discussed the intrinsic disadvantages of the customary system of weights and measures and reiterated the basic features and desirable attributes of the metric system. The report went on to consider the metric system as used in scientific work, the benefits to be derived by educational interests, the relations to manufacturing interests, the necessity of the metric system in commerce and its relation to everyday trade. These discussions all led up to the predictable conclusion that:

> "Your committee believes the time has come for the gradual retirement of our confusing, illogical, irrational system, and the substitution of something better. The first step in this direction should be the introduction of the metric weights and measures into the Departments of the Government. The use of these weights and measures will simplify their work. It will familiarize the people with them and encourage their application to the common affairs of life. Your committee have no doubt that the benefits to be derived will far more than compensate for such inconvenience and expense as may be involved in the change [93]."

Were it not for one small fact, this particular report of the Committee on

Coinage, Weights and Measures would not be considered very unusual. What made it noteworthy, although this was not known at the time, was that it was to be the last Congressional Committee report dealing directly with the metric question until 1937! Shortly after the report was issued, the controversy surrounding this subject grew to such proportions that it became impossible for the Committee members to agree, even among themselves, to favorably recommend passage of a metric bill. For all practical purposes, then, 1902 was to be the last year in which the system had a chance to obtain approval from Congress for decades to come. This opportunity was not taken. No action occurred in Congress as a result of this report, although it did stimulate men to action elsewhere. Even more important than the dissent voiced at the hearings was a substantial increase in general interest in and attention to the metric question from 1902 onward. It marked the transition point of this era in the history of the metric system in the U.S. What had usually been taken for granted up until now was to be challenged, loudly and emphatically, at every turn from this point on.

F. RISING OPPOSITION

The onslaught which began late in 1902 continued unabated until 1907. Its causes included the generally pro-metric sentiment voiced at the hearings on the 1902 metric bills as well as the favorable report of the Committee on Coinage, Weights and Measures, which had minimized the importance of the adverse testimony that had been placed before it. In addition, a number of nonofficial organizations had taken steps favorable to the cause of metric adoption, and this, too, helped to stir up opposition.

The American Metrological Society, whose efforts had been sporadic over the past few years, made one last attempt to generate popular enthusiasm for the metric reform in 1902. It formed a committee on legislation, headed by the astronomer Simon Newcomb and including Dr. Stratton, that compiled and published a small booklet containing statements of opinion favorable to metric adoption [94]. These statements were excerpted from letters and Congressional testimony of "representatives of the leading industries, interests, trades and manufacturers." The statements were organized by field of endeavor and covered a very wide range of interests including architecture, banking, engineering of all kinds, railroad work, export trade and textile manufacturing. It was even possible to ascertain from this booklet the opinions of a leading cloak maker and a window shade manufacturer. It was soon to become evident, however, that the Metrological Society had not heard from the majority of the nation's manufacturers.

A far more accurate indicator of impending developments on the metric front was contained in a discussion of the subject that was held at the Franklin Institute in Philadelphia on February 19, 1902 [95]. The preceding November the Institute had appointed a committee, chaired by James Christie of the American Bridge Company, to report on the feasibility and advisability of adopting the metric system. This committee had found in favor of the proposition and was recommending that the Franklin Institute approve appropriate resolutions at the February meeting. When the subject was opened for discussion Mr. George Bond of the Pratt and Whitney Company took the floor to oppose the resolutions. In his remarks Mr. Bond criticized the recent Congressional hearings—"I understood at the time of my attendance that it was to be a meeting called for manufacturers, and I was surprised to find myself the only one, except for one gentleman,[16] who represented a very important industry (optical instruments)" [96]—and then made a prediction which would prove to be very accurate:

"As far as concerns the clause relating to compulsory use otherwise than in the Government Departments, that is not so clearly stated; but it implies compulsory adoption in about two and a half years. That is the way it is interpreted by persons who are quite familiar with the text as represented by the bill, and it certainly will not be thus accepted and allowed to pass without a protest which will be entered by many manufacturers. It may not be by a majority, but there will be some who will demand to be heard in the matter [97].

On this occasion the defenders of the metric proposals carried the day and the resolutions were adopted but Mr. Bond would be in the majority in the not too distant future.

On April 2, 1902, the *New York Times* brought the matter completely out into the open, and added a flourish of its own:

"The 'pernicious activity' of those who are trying to crowd the metric system of weights and measures upon the country has been so far successful that they have succeeded in inducing the House Committee on Coinage, Weights and Measures to report favorably the Shafroth bill . . . For this result the country is largely indebted to Dr. S. W. Stratton, Director of the Bureau of Standards.

The spirit which has prompted this propaganda would be glad to see it made a State prison offense to speak or even think in feet, inches, pounds, or other crude units of the so-called English system; but with admirable self-restraint they are temporarily content with legislation which places every practicable obstacle in the way of retaining in ordinary use the familiar standards which from every point of view are really very much better than the arbitrary and practically inconvertible standards of the French system . . .

. . . To effect the changes which the Shafroth bill so airly prescribes will cost more than the capital of the United States Steel Corporation, and benefit no one except the specialists of the Bureau of Standards who, to avoid the concession of expressing their results in terms conforming to the accepted standards to which every detail of American shop equipment is adjusted, deem it

[16] Mr. Brashear.

entirely proper to impose upon the people of this country the yet more difficult task of converting feet and inches into millimeters to the seventh place of decimals.

The metric system is already a legal standard. Any one may use it who wants to; it is because so few want to that the advocates of the system are impatient. Those for whom the subject has interest should lose no time in communicating with their Senators and Representatives. Further legislation on the subject is wholly undesirable and entirely unnecessary [98]."

On July 1, 1902, Congress adjourned for the summer and autumn months without having given further consideration to the Shafroth bill. Supporters of the measure promised that it would be taken up when Congress reconvened, however, and a special Senate committee appointed to consider the bill announced that it would hold hearings without delay [99]. Director Stratton, returning from an extended European tour, was quoted as saying:

"It will be a close race between the United States and Great Britain as to which shall first adopt the system for all official, as well as private transactions . . . . The whole movement is being held back by a little coterie of ultra-conservatives, who, I feel confident, will not long be able to prevent the adoption of the system [100]."

Congress reconvened on December 1, 1902, with the supporters of the measure well aware of the fact that they would have only three short months in which to guide the bill through the entire remainder of the legislative process before readjournment. Chairman Southard announced his intention to proceed with the task by applying to the Committee on Rules for a special order to consider the bill, but a concurrent development in professional circles caused him to have second thoughts on the matter [101].

At the December 1902 meeting of the American Society of Mechanical Engineers, held in New York, the metric question was made the main topic of discussion [102]. As the ASME was the only major engineering society not supporting the metric system at the time, its actions were of considerable importance to Chairman Southard and Dr. Stratton, both of whom were in attendance at the meeting.

The fact that the question was going to be discussed was well known. Mr. Frederick A. Halsey, the associate editor of *American Machinist* magazine, had prepared a lengthy paper in opposition to the metric system which was distributed beforehand for discussion at the meeting. Also, following the universal custom of professional societies in such matters, the American Society of Mechanical Engineers had appointed a committee to investigate the desirability of metric adoption in 1896, and its report was due to be considered in New York. With the possible exception of the 1872 University Convocation of the State of New York, this meeting was to be the first extensive public debate on the merits of the metric system outside of Congress in which both sides were represented. More than any other single event, it signalled the beginning of the end for metric legislation.

To start with, Mr. Halsey's paper was presented [103].[17] Mr. Halsey had become upset over the "overwhelmingly one-sided" testimony which had been given to the Committee on Coinage, Weights and Measures. He took it upon himself to refute what he called the "errors of and misrepresentations by the metric advocates," singling out Dr. Stratton in particular. His chief themes were that the metric system had failed to displace the customary systems in many foreign nations, and that adopting the metric system in the U.S. would necessitate abandoning our mechanical standards (such as those for screw threads), which were, technically-speaking, more perfect and were more uniformly used than those of any nation in the world at that time. To demonstrate the validity of his views he put forth reams of evidence garnered from a great variety of sources. He was particularly well informed with regard to the persistence of customary units in the textile industries abroad, and Mr. Halsey acknowledged a debt of gratitude to one Samuel S. Dale of Boston for this information. Mr. Dale was the editor of the *Textile World* and a gentleman from whom much more would be heard in the future. Mr. Halsey's own investigation had led him to conclude that:

> "The scientific method has demonstrated beyond the possibility of a doubt that changing a people's system of weights and measures is a matter of mountainous difficulty and of endless confusion. It is time that the American Congress learned this fact. If we keep silent now our voice can have little weight later. Now is the time to speak if we are to speak with any effect [104]."

Mr Halsey's paper unleashed a torrent of reaction from his colleagues. Several dozen letters had already been received by the date of the meeting (due to the advance distribution of the paper), and additional comments and evidence were sent in later and published in the Society's *Transactions*. As might be expected, there was a wide diversity of opinion on the question. One of the communications printed, for example, was from Mr. Fred J. Miller. Mr. Miller was editor of the *American Machinist* (and, therefore, Mr. Halsey's boss) and he was inclined to favor the proposed legislation. One of the reasons he cited for not opposing it was the fact that he had evidence, in the form of a letter from U.S. Attorney General T. C. Knox, to support his contention that the bills would not compel everyone to use the metric system to the exclusion of all other systems. Mr. Knox's letter, which was printed in full, stated his opinion that:

> "Our present system has always been and is just *as* much the legal standard of weights and measures as if it had been so declared by statutes . . . And so it would be under either of these bills [H.R. 123 or H.R. 2054]—just as the parties may express themselves in any language they choose, so they may designate weight and measure [in contractual proceedings] . . . by any system that expresses their meaning [105]."

[17] Mr. Halsey later expanded this paper into a full-fledged book on the subject, *The Metric Fallacy*. Since the book will be treated fully in the next section, only the highlights of his 1902 paper will be given here.

Mr. Knox's letter went on to state that it was doubtful that Congress had sufficient authority under the Constitution to forbid the use of a particular system of weights and measures, especially one so ingrained in custom as the English system as in the U.S. But this fact was not relevant to the case at hand, he said, because:

"It is certain that nothing of this kind is done by the adoption as the legal standard of a system of weights and measures different from that now in vogue, and which, so far as the people are concerned, merely adopts the metric system as the legal standard and launches it under Government auspices and recommendation without any attempt to compel its use by the public at large [106]."

The Attorney General's opinion notwithstanding, many people remained convinced that the real purpose of the legislation proposed was to force the metric system upon the nation. In fact, this belief would become the keystone of the anti-metric argument over the next few years.

Mr. Halsey's paper, along with other apsects of the question of metric adoption, were also debated orally at the December 1902 meeting. The first rebuttal was offered by Dr. Stratton,[18] who defended the desirability of the reform and attempted to counter Mr. Halsey's assertion that the metric system had been a failure abroad by reciting some personal observations that he had made first-hand during his recent trip. Dr. Stratton also added:

"It is especially gratifying to note that there is a rapidly growing sentiment in favor of the adoption of the metric system on the part of manufacturers and business men of the country. The very spirit of progress which has made our manufacturers leaders of the world will not allow them to forego the advantages of an improvement because that improvement is difficult to make [107]."

He would have occasion to eat those words long before the decade was out.

Chairman Southard next took the floor to explain more fully the provisions of the Shafroth bill, to defend its desirability, and to justify the action of his Committee with respect to it. He stated that the Committee's intention during the last session of Congress had been to obtain statements from those who were likely to oppose the adoption of the metric system. With that in mind they had invited Mr. Bond, Coleman Sellers, and several major manufacturers to address the Committee. The result, he said, had been the same as from previous investigations—the testimony was very much in favor of the bill. He then discussed at great length the intent of the bill:

"[T]his is a proposition to try this matter on the dog—to try it on the Government first. If the government cannot stand it, then we have no right to ask the people to stand it. There is nothing in

[18] Neither Dr. Stratton nor Chairman Southard were members of the Society, but they had been invited to participate in this meeting because the metric question was on the agenda.

the provisions of this bill which will in any way interfere with your business . . .

I believe that the metric system is coming just as surely as the tides are going to continue to rise and fall. The tendency is all in that direction. I cannot see it in any other way. Now, the question is, if we are going to have it ought we not help it along a little? If we are going to have it at all, the sooner we get it, the better. Now, why can't we try the experiment on the dog? . . . In my judgment, it is not going to cost you a dollar [108]."

Mr. Southard's address provoked a lengthy and lively question-and-answer period from the members in attendance, with Mr. Halsey figuring prominently in the debate. The lack of a concensus within the Society on this issue soon became clear, but it appeared that most mechanical engineers remained unpersuaded as to the desirability of metric adoption. When the question was put to a formal vote on the following day, December 5, however, it was apparent that Southard and Stratton had scored at least a few points.

The vehicle for expressing the Society's formal opinion on this question was the report of its special investigative committee, which had been deliberating since 1896. This committee had submitted a decidely anti-metric report. The advantages of the customary system, it declared, "render it certain that before the close of this century the English system of linear measurement will come into universal use; when the Metric System . . . will have disappeared, as its supposed scientific foundation has done already [109]." In accordance with this opinion two resolutions were offered for the Society's approval. The first of these asserted that mechanical engineers were the only parties in the country who were competent to determine which measurement system was most appropriate for their own use, an obvious appeal to the Congress to mind its own business. The second resolution was even more forthright in this respect:

"*Resolved*, as for the bill now before Congress, providing that the Metric System shall be the legal system of weights *and measures* in the United States, and making its use obligatory in the government departments, that, so far as it affects mechanical measurements, conceived in ignorance, it is simply absurd [110]."

By a vote of 36 to 22, however, a motion to lay these resolutions on the table was carried. Instead, a new committee was appointed and instructed to confer with other professional societies before rendering its opinion. The Society did pass a resolution, however, declaring that it had never taken any action reversing its original stand of opposition to the adoption of the system, as had been reported in the technical press.

The second committee, consisting of George Bond, James Christie, William Kent and Fred J. Miller, all respected members of the Society, turned in a lengthy report at a later date [111]. This report, which contained no recommendations for action, was far less anti-metric than the previous report, which had been written by Coleman Sellars. It did assert that legislation designed to compel the exclusive use of the metric system was not desirable and could not, in any case, be enforced with respect to private, individual transactions. Beyond that, however, the committee took no strong position on the matter. In fact, its report was, more than anything else, a catalog of pro-metric and anti-metric arguments and each side's reply to the other's contentions. In all, there were 23 pro-metric arguments listed, along with anti-metric rebuttals, and 10 anti-metric arguments cited, along with pro-metric replies. The committee had divided evenly on the matter, with Mr. Christie and Mr. Miller favoring the metric system and Mr. Kent and Mr. Bond being opposed. The opinions of related groups, as expressed in their own literature, were printed as appendixes.

Early in 1903 the American Society of Mechanical Engineers also conducted a poll of its membership by mail to determine the prevailing attitude on the question of metric adoption. As only 514 members out of a total of over 2,500 responded to the survey, it was deemed by the Council not to be sufficiently representative to serve as the official position of the Society as a whole, and it was simply recorded without further action being taken [112]. The results were interesting, nevertheless, as they show that there was apparently an even stronger faction against the metric system within the Society than had been heard from at the New York meeting. The questions asked and the replies received may be summarized as follows [113]:

1. On the question of adopting the metric system as the only legal standard in the United States:	
In favor	103 (22%)
Against	363 (78%)
2. On enactment of H.R. 2054:	
In favor	95 (22%)
Against	342 (78%)
3. On legislation which would promote adoption of the metric system:	
In favor	153 (33%)
Against	311 (67%)
4. On the effect of substituting the metric system for the English system in the respondent's business:	
Detrimental	243 (51%)
Not detrimental	145 (30%)
Advantageous	89 (19%)

By the time the results of this ballot had been counted and made public, however, the question was an academic one. As reported by *Iron Age* in early February 1903:

"The friends in Congress of the metric system bill have decided not to press the measure further at the present session. This decision has no bearing upon the merits of the bill as they are viewed by the leading members of both Houses and is due only in part to the present parliamentary situation. The principal reason is that the advocates of the proposed change believe that the campaign of education should be carried on a little longer in the country at large before an attempt is made to place the metric system on the statute books.

. . . [T]here are still a few prominent and influential men who are so strongly opposed to the system that its introduction would probably be resisted in a manner and to such an extent as to justify the current predictions concerning the confusion that would be caused by the change, especially among tool builders and other manufacturers of metals. Mr. Southard and his friends here do not wish to force upon the country a change for which it is not quite ready, and they are confident that in a few months the sentiment of the rank and file, if not the leaders, of the opposition will be so modified that the bill can be passed and the change made without serious difficulty.

So far as the Congressional situation is concerned, there is good reason to believe the bill would pass both Houses by a comfortable majority if brought to a vote. The House has been canvassed with much care and shows a large majority for the bill . . . . In the Senate the canvass has been less thorough, but indicates that there is a safe majority for the bill . . .

The present plans of the friends of the metric system bill are to reintroduce it early in the 58th Congress and to report it soon after convening on the strength of the hearings given during the first session of the present Congress [114]."

But this plan was not to be so easy to carry out as it was made to appear. Real opposition had been aroused in 1902, and it would not be easy to circumvent it. Instead of disappearing, it spread. In the course of one short year the nature of Chairman Southard's problem had changed. At the start of 1902, he had been dealing with a bill which by most accounts, had been considered beneficial and progressive. All that remained for him to do was to guide it through the legislative process. By the end of the year, Mr. Southard had a growing controversy on his hands and he knew it. In spite of the optimistic view of the Congressional situation which he projected publicly, his action in not pressing the matter at that time indicated that his true feelings on the matter were less sanguine. Withdrawing from the action would give him time to reorganize the supporters of the bill and to attempt to reassure the opponents of it. Unfortunately for Mr. Southard and his colleagues, the opposition was in no mood to be appeased and used the time to their own good advantage.

G. "THE METRIC FALLACY"

Before the metric campaign could be resumed in earnest on the Congressional front, Messrs. Halsey and Dale had taken their case to the public. Building upon the paper presented by Mr. Halsey to the American Society of Mechanical Engineers, the anti-metric arguments were set down in more comprehensive form in a book entitled *The Metric Fallacy* [115]. Mr. Dale's contribution was further identified under the title of "The Metric Failure in the Textile Industry." This work, published in 1904, and revised in 1920, would become the most well-known treatment of the subject since John Quincy Adams' 1821 report. Unlike Mr. Adams' discussion, however, no kind words for the metric system appeared between the covers of *The Metric Fallacy*. Because of this, the book, its arguments and its authors became a rallying point to which metric opponents could, and did, repair. The question of metric adoption had once again become a controversial issue.

Perhaps the most lasting impact of the Halsey-Dale collaboration was not on public opinion but, rather, on the authors themselves. In the process of producing *The Metric Fallacy* they had formed a common bond which was to last more than a quarter of a century. The real fruits of this anti-metric partnership would not become apparent until 1917 and beyond, and the relationship between the two men would often be threatened by disagreements over how their common objective could best be achieved. In the end, however, they would manage to reconcile their differences in time to meet each new pro-metric drive head-on and insure its ultimate failure. Although that story belongs mainly to the era which will be recounted in the next chapter, its origins and initial successes occurred during the years 1903-1907.

Frederick Arthur Halsey was born in Unadilla, New York on July 12, 1856 [116]. He received his engineering degree from Cornell in 1878 and from 1880-1894 was the engineer for a New York drill manufacturing firm. While there he worked out one of the earliest incentive plans for paying for labor, a premium plan for which he would receive the American Society of Mechanical Engineers Medal in 1923. The rest of his professional life was spent on the staff of the *American Machinist* first as associate editor (1894-1907) and later as editor in chief (1907-1911). After his retirement in 1911, Mr. Halsey helped to organize and run the American Institute of Weights and Measures, an anti-metric group of a later period. He was the author of several books not dealing with the metric system, in addition to *The Metric Fallacy* and a great many other anti-metric articles and pamphlets. His writings and correspondence reveal a broad hostile streak in his personality, although he was apparently possessed of at least one of the social graces—he was said to have been an excellent ballroom dancer. He died in New York on October 20, 1935.

Much less is known for certain about the details of Samuel Sherman Dale's life, although his interests are well-chronicled [117]. It is known that he was born in Little Falls, New York in 1859, lived in or around Boston most of his life, and died there about 1935, making him a contemporary of Mr. Halsey in every respect. He began his career as a worker in a woolen mill in 1875 and was made superintendent of an Uxbridge, Massachusetts mill in 1887. His principal life's work was also as an editor. Mr. Dale edited the *Textile World* and the *Textile World-Record* from 1898 until 1915. In 1915 he purchased the magazine *Textiles*. He edited it himself for many years, although he eventually sold out to a larger publishing firm. In 1923 he became a "technical expert" for the Carded Woolen Manufacturers Association. Aside from the metric system battles, to which he was attracted by his belief that metric adoption would adversely affect textile manufacturers,

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he spent most of his time working to lower the tariff schedule on items important to textile manufacturing [118]. Along with Mr. Halsey, Samuel Dale worked actively to establish the American Institute of Weights and Measures, but he always preferred to work behind the scenes. He avoided personal publicity unless it was absolutely necessary to show himself. Of the two individuals, Samuel Dale would develop into the chief strategist of the anti-metric forces and Mr. Halsey would do his best to make the plans work.

In 1903-1904, however, it was Frederick Halsey who played the lead role in the fight against the metric system. *The Metric Fallacy* was designed to meet the metric advocates on their own ground by presenting a point-by-point refutation of pro-metric arguments. Mr. Halsey's objective was, he said, to establish the validity of the following propositions:

"1. That as shown by the experience of other countries, the changing of a people's system of weights and measures is a task of enormous difficulty, and is attended with wide-spread confusion . . . It may . . . be considered as proven with us, and especially without general compulsory laws, which the metric advocates disclaim, the change is impossible.

2. That the adoption of the metric system, meaning by that term the retirement of the inch and the substitution therefor of the millimetre, involves the destruction of all mechanical standards . . .

3. That the prosperity of foreign trade in nowise requires the adoption of the system as a basis of manufacture . . .

4. That the bill now before Congress is a compulsory measure, so far as it relates to those who do business with any of the departments of the government . . . .

5. That the metric system has for industrial purposes no such superiority as is claimed, and that the claims for the saving of time in calculations and in the school life of children, are completely negatived by the certainty that, here as elsewhere, the old units will persist in use and must be learned . . .

6. That the confusion which is said to prevail in our weights and measures is a fiction . . . . [and]

7. That, measured by the number of units in common use, and by their uniform value in all sections and all industries, we have the simplest and the most uniform system of weights and measures of any country in the world [119]."

The balance of Mr. Halsey's part of the book was devoted to elaborating on these points.

The main thrust of his attack was aimed at the pro-metric contention that the metric system had been adopted, without difficulty, by virtually every advanced nation in the world except Great Britain and the U.S. and was being used by two-thirds of the world's population. "No man living or dead" Halsey countered, "has even seen the first scintilla of evidence that these statements are true." In a series of successive chapters, he went on to offer evidence of his own to show "the persistence of old units" in German textile industries, French textile industries, German mechanical industries, and every nation that he could find anything on, including France, Scandinavia, Greece, Turkey, China, Japan, Egypt, the Phillipine Islands, Spain, Mexico, Cuba, other Spanish-American countries, and metric countries in general.

To prove his points, he quoted extensively from letters he had received from individuals either living or working abroad and from articles in professional journals and trade magazines. Thus Mr. Halsey's "evidence" was, in reality, little more than a collection of personal opinions which, in all probability, the metric advocates could have matched had they chosen to do so. In later testimony before the Committee on Coinage, Weights and Measures Mr. Halsey conceded that he had not observed the situation first-hand and that he had relied on his correspondents to supply him with accurate information. The lack of direct personal observation in no way lessened the impact of *The Metric Fallacy,* however, and may even have helped to establish its credibility by making up in numbers and persuasiveness for any shortcomings it may have had.

One of the most impressive pieces of real evidence that Mr. Halsey offered was a table entitled "Non-Metric Units Used in Metric Countries." The table had been extracted from an official U.S. State Department publication listing English equivalents of commonly-used foreign weights and measures [120]. In all, no less than 265 different non-metric units were listed as being used by so-called "metric countries."

From all of the above material Mr Halsey was able to deduce that:

"The fatal mistake of the metric advocates and the weakness of their case lies in their assumption that the statute book is an index of the practice of the people.

The arguments for the saving of time in calculation, for the simplification of our weights and measures and for the saving of time by school children are all based on the tacit assumption that the old units are to disappear. As they have not done so elsewhere they will not do so here, and every one of these arguments falls to the ground. The whole metric case is riven into shreads by the simple fact that these old units will not die.

Shall we carry our heads in the clouds of speculation, or shall we consult the experience of others? Shall we join in the chase of this will-o'-the-wisp which no nation has ever caught? That and that only is the metric question of the hour. Arguments based on the beautiful interrelation and correlation of the units have little more application than a philosophical speculation regarding the appearance of the back side of the moon [121]."

The reasons for the failure of compulsory metric laws, Mr. Halsey offered, were to be found in the fact that no government had the right to tell an individual what measurement system he must use in manufacturing his product: "goods may obviously be made according to the maker's own sweet will provided the customer will accept them [122]," he asserted. In such cases, the legal adoption of the metric system, would only create additional confusion, by forcing the merchant to sell a product that had been manufactured by the customary system according to its equivalent metric measurements. Mr. Halsey also went on to explain why he felt it had taken so long for the system to catch on: "either the change is too difficult to be made or a century of experience has not sufficed to demonstrate the superiority of the metric system [123]." Utilizing a favorite phrase, he advanced the idea that:

"Measures of length are tied irrevocably to the past . . . If this system were made compulsory tomorrow and the people were to receive it with enthusiasm, the gas pipes in the ceilings of our homes alone would keep the old system alive for 50 years [124]."

Similar arguments were used by Mr. Halsey in making the rest of his case. Among his major contentions, which were soon to be taken up by a good many of his colleagues, were the ideas that:

1. The character of scientific and industrial measurements was fundamentally different: "The scientific use of measurements consists in measuring existing things; the industrial use of measurements consists in making things to required size [125]." This difference meant that a manufacturer or engineer was forced to choose a limited set of sizes and stick with them if confusion was to be avoided. A scientist, on the other hand, was faced only with the problem of how to express the results of his measurement. This alleged difference also accounted for Mr. Halsey's belief that adopting the metric system would necessitate abandoning all of the existing mechanical standards.[19]
2. The promise that the Government would absorb the cost of the changeover by permitting companies to include expenditures for new tools, gauges, etc., in its bids was a false promise. His line of reasoning for this assertion was that all manufacturers would be on an equal footing only the *first* time a new contract was put up for bid. After the Government had paid for that manufacturer's new tools, he would ever after have a competitive edge, since all rival companies would have to include the costs of new tools in their bids while he would not.
3. The theoretical superiority of the metric system was "a bagtelle." Everyone knew that the meter was not what it purported to be, i.e. a ten-millionth of the earth's quadrant; that may of the original parts of the system (such as the decimal division of the circle) had failed and been abandoned long ago; and that the much-touted advantages in calculation offered by a decimal system had been made unimportant altogether by the invention of the slide rule.
4. A mixture of units, such as would necessarily occur for a long time if the metric system were adopted, would cause untold complications,

[19] That is the specific engineering standards which a particular industry had agreed to follow in practice when manufacturing an item, such as screws or bolts.

including the destruction of the usefulness of a vast technical literature.

5. American foreign trade had not been affected so far by our adherence to the English system, and our manufacturers had already learned to make products in metric dimensions when it was necessary to the maintenance of their business abroad.
6. That the proposed bill, by making the metric system compulsory on the Government, would also make it compulsory upon those seeking to do business with the Government. If this were not the case, Mr. Halsey pointed out with considerable logic, the only effect the bill could have would be to put into use in the Government a system of weights and measures that was different from the one used by the rest of the people. Any bill having this as its object was a bad one and ought to be defeated, Mr. Halsey believed.

All of these views he summarized in his concluding statement: "The changing of established standards is impossible. Their measurement in millimetres is equally impossible. Established standards will, therefore, preserve the inch. The millimetre may be forced into use, destroying our present uniformity and introducing the diversity which everywhere accompanies the use of the metric system, but this is all that can be done. These people may legislate until doomsday; they may make infinite confusion, endless turmoil, limitless sacrifice, but move the English inch?—the Archimedean lever is still unknown [126]."

Mr. Dale's chapters on "The Metric Failure in the Textile Industry" presented his views as to why the metric system was not suited to that trade. On the whole, his arguments were more factual, more logical and far more technically oriented than Mr. Halsey's. For these reasons, they were also considerably less interesting. In fact, the textile chapters had the general flavor of a textbook on the subject, liberally interspersed, of course, with editorial comments. Nevertheless, he offered some very convincing reasons for his opposition to the metric system's adoption.

To begin with, Mr. Dale reviewed the way in which sophisticated mill practices involving weight and measurement had evolved, both at home and abroad, over the last one hundred years, emphasizing how intimately such practices were connected with the quality of the finished product:

"The yarn count, or length per pound, means a certain appearance of the yarn, a certain strength and elasticity; it tells what production should come from each machine, and how much should be paid for spinning 100 pounds or hanks. It is the standard of the experience in the past, the work of the present and the possibilities for the future [127].

It should be obvious to anyone acquainted with the business, he thought, that a radical alteration of the system of weights and measures employed would upset all of the experience that had been built up over the years, would negate the training of mill superintendents and invalidate their literature, and would utterly destroy the efficiency of any mill for a period of time. He was also concerned that adopting the metric system would cause confusion in the marketplace by overturning the accepted standard of values. Since textiles had perennially been bought and sold by the yard, adopting a measure more than 3 inches longer would throw the entire marketplace into confusion while the adjustment was being made. Another thing that would help to make the change extremely difficult, if not impossible, was, according to Mr. Dale, the human factor:

> "The vast army of hard-working men, women and children engaged in our textile mills, most of them with but an elementary education, highly organized to work together with the precision of machinery in the conversion of fibres and filaments into fabrics, have become familiar with the established weights and measures in the hard school of experience. Their ideas of the yard, inch, pound, ounce, dram, and grain as textile standards have been acquired while toiling long hours, day in and day out, for years in noisy, nerve-wracking mills. In such a matter as changing of standards of weights and measures, each and every one is naturally a confirmed conservative. Their personal resistance to changes of acquired habits and ideas defies all efforts and arguments [128]."

The proof of these contentions, Mr. Dale said, was to be found in the actual experiences of the European textile industry, which had been struggling with the problem since France made use of the metric system compulsory. He reviewed these experiences, especially in France and Germany, basing his analysis on the applicable parts of foreign textile books and actual operating manuals. His findings were that adoption of the metric system had simply added several more units of measurement to the already "hopeless jumble" of measures that had to be taken into account. In no instance had the metric system totally displaced the old units, nor would it ever be able to do so because English textile measures had set the standard for the rest of the world to follow. By contrast, Mr. Dale stated, the English system was the *only* standard used in textile manufacturing in English-speaking nations. This uniformity had given us advantages which Mr. Dale thought were insurmountable, and he found it inconceivable that people were proposing to abandon such advantages by adopting the metric system.

There was, Mr. Dale concluded, no reason why the change should be made and many reasons why it should not be. The diversity of weights and measures which had existed in pre-metric Europe had been an imperative reason for reform, but those same conditions did not exist in 20th-century America. Nor was the political situation in this country analagous to the one which had prevailed in Europe:

> "We have no king to order a change of our standards of textile weights and measures, no established church or aristocracy to execute royal decree. In the place of a people accustomed to being controlled

by an arbitrary government, we have a people who govern themselves, and who are quick to resent the interference of the police power in their private affairs.

. . . Today no demand for such a change comes from the American people. Our English standards have become a part of our lives and are interwoven with all our occupations. Any attempt to change these standards would be resisted by an inertia far more effective than the power exerted by the French people over one hundred years ago in favor of the metric system.

. . . The generation introducing the metric system into the United States would not see the beginning of [the] chaos. In all probability, no other generation would ever see the end [129]."

By means of *The Metric Fallacy*, Frederick Halsey and Samuel Dale had served notice on the world that they were ready to fight the proposed reform to the bitter end. They saw it as unneeded, unwanted and harmful—an intrusion by the Government into the private affairs of the nation's business interests. There was no way, they felt, that the change could be forced on a people who didn't want it, and if it was not wanted it shouldn't be made. Apparently, it was this very argument that dozens of individuals, and manufacturing interests in particular, were waiting to hear. At the next Congressional hearings on the subject they lined up by the score to make their opposition known.

In the pro-metric camp the reaction was equally swift. Reviewing the book in the pages of *The Physical Review*, C. E. Guillaume of the International Bureau of Weights and Measures protested that:

"Among the authors who have undertaken to combat the metric system none has been more harsh, and, we are compelled to say, less fair than Mr. Halsey. For several years he has employed in the combat against this admirable system an amount of effort, perseverance, and vehemence worthy of a better cause; bringing forward arguments whether good or bad, and finding even in the most beautiful relations of the metric system reasons for opposing its adoption. His work is voluminous; it abounds in assertions, in citations, and in tables whose appearance of having been duly and seriously verified might easily deceive [130]."

Professor W. LeConte Stevens of Washington and Lee University was even more derogatory in his review of the book for *Science* magazine:

"[It] is evident on every page of his book that he is a carping critic, much given to extreme forms of expression . . . The writer who resorts to sarcasm whenever the chance is presented, who confounds railing with argument, who suppresses or belittles everything that tends to controvert what he wishes to advocate, has only himself to blame if he forfeits the confidence of those who consider fairness an essential element in the effort to get at the truth. . . . The role of the prophet is often unsafe; as unsafe as the exhibition of rage in print [131]."

Professor Stevens did go on to warn his readers, however, that there was a great deal of material contained in *The Metric Fallacy* that would have to be taken into account in future debates, "despite the unbalanced intolerance of Mr. Halsey and the ungenerous personality manifested by Mr. Dale [132]" He cautioned that a good deal of time and practical experience in using the metric system would be required before its final adoption could be achieved, and expressed the belief that supporters of the proposition were deceiving themselves if they believed otherwise. This fact alone, however, he did not consider to be a damnation of the entire idea and he urged a continuation of efforts to secure favorable legislation.

Such efforts were, in fact, already being made and another round of debate on the proposition was about to begin. Its outcome would seal the fate of the metric system in the U.S. for more than a decade, and the debate itself would bear very little resemblance to the overwhelmingly favorable testimony received by the Committee on Coinage, Weights and Measures between 1896 and 1902.

H. THE ROAD TO OBLIVION

The next set of Congressional hearings on the metric system began in January 1904, continued through two consecutive Congresses, and eventually concluded in April 1906. In all, 44 different witnesses were heard (many on more than one occasion) and nearly 600 pages of printed testimony were generated [133]. This was to be the most extensive set of hearings ever held on the metric proposition. The entire process was devoid of productive results, however, since the printed testimony and a great deal of controversy was all that ever came of these hearings. Neither side was to get the satisfaction of achieving a decisive victory since all of the bills introduced during these years expired without even being reported by the Committee on Coinage, Weights and Measures. For the time being, the opponents won out. But the issue had not been killed, it had only been put on the shelf to await a more favorable opportunity. The hopelessness of the pro-metric cause had become readily apparent by 1907, but this conclusion was reached only after both sides had been given the chance to exhaust their entire supply of arguments, both before the Committee and before the rest of the world.

On the first day of the 58th Congress, November 9, 1903, Mr. Shafroth dropped into the hopper a metric bill,[20] that was identical to those of the last few sessions except for the dates on which the bill was to become effective. These had been advanced to January 1, 1905 (for the Government) and January 1, 1906 (for the rest of the Nation). In spite of Chairman Southard's previously announced intention to proceed with issuing a report on the strength of earlier hearings alone, new hearings were scheduled and got under way on January 21, 1904.

It had obviously become imperative to give the opposition a chance to be heard on the metric question, and the first set of hearings in the 58th Con-

[20] H.R. 93.

gress served that purpose. By the time they were concluded, on April 7, 1904, 18 witnesses had been heard and all had come to oppose the bill. The procession was led by Frederick Halsey and Samuel Dale, but it also included other men who either had been or would be lifelong adversaries of metric adoption, such as William Sellers, of the Coleman Sellers firm; Henry R. Towne, the president of Yale and Towne Manufacturing Company; George Colles, the mechanical engineer who had recorded his objections to the metric system in 1896; Luther D. Burlingame, of the Brown and Sharpe Manufacturing Company; and Walter M. McFarland, of Westinghouse. Chairman Southard had finally succeeded in getting the country's businessmen to talk to the Committee about this matter, but the results were not quite what he had anticipated. In place of the growing enthusiasm for the proposition which both Mr. Southard and Dr. Stratton had ascribed to members of the manufacturing community, the combined forces of Halsey and Dale and the debate before the American Society of Mechanical Engineers had aroused these interests to opposition.

Their complaints were many. First and foremost was their opinion that there was no advantage to be gained by adopting the metric system, but that several disadvantages existed that they would have to undergo in making the change. The people who were advocating the change, the manufacturers felt, were scientists and theorists who had no personal stake in the problems involved. Industry, on the other hand, would have to suffer the enormous economic losses involved in changing over their gauges, jigs, drawings and machinery. There was also the problem of re-educating the workers in the new system, along with the great amount of time and material that would be wasted until the workers could learn to adjust their daily habits to a new system. The result of metric adoption, in short, would be to throw the manufacturers into a state of utter confusion until the system could be assimilated, a process which they estimated would take many years.

The manufacturers also believed that the probable impact of metric adoption on foreign trade had been grossly overestimated. No matter what measurement system was used, it was claimed, American products would continue to sell well in foreign markets because they were superior products—more precisely engineered, more durable and cheaper. In addition, service and replacement parts were easy to obtain. It was also stated that manufacturers already made products to metric standards when it was advantageous to do so, but that high tariffs on American imports made it difficult to compete in some countries, especially those that were strongly metric. With the tariff situation so unfavorable, American conversion to the metric system would make little or no difference in the size of U.S. foreign trade.

The argument was also advanced that the English customary system of weights and measures had features which were superior, for many applications, to those of the metric system. Its advantages included the convenience of the English inch for many uses and the binary nature of the English system. Turning the pro-metric argument around, the opponents pointed out that the English system was perfectly amenable to decimal division; even more so, in fact, than the metric system was to repeated binary division.

Manufacturing frequently called for machining to very close tolerances, it was pointed out, and in such cases a decimalized English system was already being used. Most opponents argued that the English system could be and should be perfected, but it should never be scrapped because linear measurements were already on a uniform basis throughout the English-speaking world.

Many other anti-metric contentions, most of them advanced on many earlier occasions, were also raised at these hearings. These included the claims that there was no popular demand for metric adoption; that all technical literature, particularly engineering handbooks, would be rendered useless; that the experience of foreign nations had demonstrated conclusively the long time period, the cost, the confusion, and the low probability of total conversion to the metric system; and that it would be utterly impossible to enforce such a law as was proposed.

It was during the first of these series of hearings that a wide rift among members of the House Committee on Coinage, Weights and Measures became apparent. Until now, the Committee had acted with one voice on this question and it had always been in favor of introducing the metric system. In 1904, opposition to the proposal began to show up among Committee members. Perhaps this was due to a realignment of the Committee between the 57th and 58th Congresses, or it may simply have been caused by the persuasiveness of the opponents. Whatever the reason, Chairman Southard, Mr. Shafroth and a Representative Lanning appeared to favor the proposition while Representative John W. Gaines of Tennessee, assisted by Congressmen Candler and Brown, lined up in opposition.

The appearance of stiff opposition to the proposed legislation, both from within and without the Committee, forced Chairman Southard to abandon his plans to secure a quick passage of the bill. Instead, the pro-metric forces withdrew entirely from the arena for the remainder of the 58th Congress after holding hearings. In fact, the January-April, 1904 hearings were not even printed and released until 1906, apparently because they were so decidedly contrary to the objectives of the bill proposed. Not until after another series of hearings had been held, on 2 days in February 1905, and from February 8 to March 15, 1906, was the full record of testimony printed and issued. By this time, a more balanced record had been compiled.

A revised bill,[21] had also been introduced early in the 59th Congress, on December 18, 1905, most likely in an attempt to mollify the fears of the manufacturers who had opposed the earlier bills. This proposal, introduced by Mr. Littauer, called for compulsory use of the metric system in all Government transactions after July 1, 1908, but omitted any reference to adopting the system as the national standard of weights and measures. Chairman Southard promptly held new hearings, having assured himself in advance, no doubt, that a more favorable reception would be accorded this proposal than had been the case 2 years earlier.

An outstanding feature of this series of hearings was an appearance by Alexander Graham Bell. Mr. Bell's testimony was an important event for

[21] H.R. 8988.

metric advocates, not just because he was enthusiastically for the bill or because he was a greatly-admired individual, but also because he made it very difficult for metric opponents to claim that only "theorists," not practical men, wanted the metric system. Mr. Bell clearly believed that the effect of the proposed bill would be to cause a general adoption of the metric system, but he defended this idea, saying:

> "The right of the individual to choose his own methods of measurement must give way to the convenience of the community of which he forms a part; in a similar manner, the right of sections of the community, like apothecaries, silversmiths, etc., to have their own peculiar systems of measurement should give way to the right of the community as a whole to have uniformity and a system convenient to all . . . [T]he United States might very well establish a peculiar system of its own without reference to the usages of other countries, if we formed an isolated people, having no dealings with the rest of the world. But in making a change—and the necessity for a change is very obvious—it would be advisable to adopt a system that would not only be convenient for our own people, but would also be convenient for the other peoples of the world with whom we carry on trade and commerce [134]."

Mr. Bell also made a convincing point with respect to the assertion that metric adoption would require all existing tools and machinery to be discarded:

> "That is a matter for very grave consideration, and I think that the difficulty has been unduly magnified . . . . The old tools and machinery need not be thrown away; they can be used during the transition period at whatever may be their metrical value. A tool or machine has only a limited life. It may last, say, 10 years, and then it must be replaced. After the adoption of the metrical system the new tools and machines would certainly be constructed to an exact metrical scale [135].

Mr. Bell was the first person to have raised the notion of technological obsolescence in response to the opposition's claims that it would require 50-100 years to complete the changeover because of the size of America's investment in durable hardware. Manufacturers were justifiably proud of the sturdy and reliable machines they marketed, and were reluctant to talk about their actual expected lifetimes. Mr. Bell met this issue head-on by his simple contention that, sooner or later, all machines had to be replaced and it would be just as easy to order new machines in metric units as it would be to order them in English units.

Dr. Stratton also appeared before the Committee, again to urge passage of the bill and to do his best to refute the major arguments of the opponents. In contrast to his previous appearance, at which he had been treated courteously and respectfully, he was interrogated at some length on this occasion as to his own interests in the matter:

"Mr. [Rep.] LILLEY: You say that the time will never come when the manufacturers cannot adopt and use any system they see fit. If this [i.e, the metric system] is so much better for them why don't they do it? Why ask us to pass some law to make them do it if they have that opportunity?

Dr. STRATTON: We are not asking that you pass any law to make them do it, but to introduce it into the Government service . . . .

Mr. LILLEY: You are doing this as a matter of philanthropy; you are not interested in it a bit?

Dr. STRATTON: I think the Government should avail itself of the advantages of the metric system, and should set the public a good example.

Mr. LILLEY: Perhaps some of these questions should come before the committee later on when we are summing up the case, but you are here, as you say, entirely disinterested, with no interest in the matter whatever. Therefore I have a right—

Dr. STRATTON: I will not say that I am not interested in the movement to adopt the metric system.

Mr. LILLEY: Are you interested financially?

Dr. STRATTON: Not in the slightest, if that is what you mean . . .

. . . .

Mr. GAINES: Now I want to get at the facts about this thing. You have been at every meeting of the committee on this point? . . . Every meeting that I have attended except one. If your bureau is not a teacher of this, if it is not interested in its maintenance, and you are not interested in the continuation of that bureau and the broadening of it, how is it you have taken such a lively interest in this?

Dr. STRATTON: That, I think comes from a definition of 'interest.' I do not understand exactly what Mr. Lilley meant by interest . . .

Mr. BOWERSOCK: Do you presume it would make any difference with you, so far as your salary and position were concerned, whether the metric system was adopted or not?

Dr. STRATTON: Not the slightest; that has nothing to do with it. My convictions in regard to the metric system were reached long before I came to the Bureau of Standards [136]."

This line of questioning did not develop spontaneously, but was, rather, prompted by the indignance of Samuel Dale. Mr. Dale, who continually referred to the National Bureau of Standards as a "metric hothouse," had protested to Mr. Gaines about Dr. Stratton's position [137]. He would later take up the matter directly with Dr. Stratton, as the following extract from a June 8, 1911, letter indicates:

"[I]t seems to me to be beyond question that your Bureau is the center of a persistent agitation in favor of the compulsory introduction of the metric system into the United States, and that the official power and prestige of the Bureau has been improperly used to further that object. I have publicly called attention to a number of cases of this kind . . .

I concede your perfect freedom of individual opinion regarding the merits of the metric system. My complaint is that you have allowed that opinion to influence improperly the policy of your Bureau . . .

All this reminds me of a conversation I had with Professor Molitor, of Cornell University, some months ago. We chewed the weights and measures rag . . . [until] one of the listeners broke in with this question: 'Well, Dale, what do you think of Stratton? Do you think he is sincere?' 'Yes,' I replied, 'I do, but the great mystery to me is how any man can get his mind into such a state as will permit him to believe what Stratton believes.' As I said this, Professor Molitor's face lighted up and he could hardly wait until I had finished when he broke out with this: 'Well, Dale, that is exactly what Stratton said about you.' The company broke out into a roar of laughter and agreed to call the discussion a draw [138]."

Although no record remains of Dr. Stratton's exact reply to this particular letter, a letter sent to Mr. Dale only two days prior to the one cited above, and which was the one to which Dale was replying, contained statements which typify Dr. Stratton's constant official position on the matter:

"I feel sure from the tone of your letters, that you understand that the Bureau is taking distinct 'measures' to secure the adoption of the metric system. While the Bureau could take no other stand than that the metric system is superior to a mixed system such as the so-called English system of weights and measures, it is not true that it is using any means except the distribution of its publications . . . to further the use of it in the country . . .

The Bureau would not wish to introduce hardship in any class; but it believes that the effect of proposed metric legislation has been greatly overestimated [139]."

Mr. Dale's attacks were by no means confined to NBS and Dr. Stratton. Another favorite target was Mr. Southard. In an April 10, 1907 pamphlet, which he had printed at his own expense, Mr. Dale took the Chairman to task for "suppressing" testimony which he had presented:

"When opponents of metric legislation appeared before the Committee in 1904, the Chairman neglected to print their testimony. In spite of repeated demands he delayed the printing of the report of the 1904 hearings for 2 years and then, March 1, 1906, was forced to consent to it only after a violent scene in the committee room in which John Wesley Gaines of Tennessee protested against further delay as an outrage. In printing the 1-year-old testimony, however, the Chairman resorted to one of his characteristic maneuvers. He also printed my anti-metric testimony of that day, March 1, 1906, in the garbled and incorrect form in which it was reported by the stenographer and

> without giving me an opportunity to correct it. In spite of repeated requests he has failed to have the testimony printed in correct form [140]."

While this was apparently a vital matter to Mr. Dale, the testimony he preserved for posterity contained no additional evidence of a novel or startling nature. In fact, the entire testimony heard (and duly printed in "garbled" form) during the Second Session of the 59th Congress is merely additional evidence of how routine the debate on this question had become. At the third series of hearings [141] 25 witnesses appeared to make their views known, 13 for the pro-metric side, and 12 for the opposition. The situation was very structured, with a total of 4 hours time being allotted to each side by the Chairman. It is not clear from the record who arranged the scheduling of the pro-metric witnesses, but the opposition slate was handled by a Mr. Cushing of the National Association of Manufacturers. It is interesting to note that Mr. Cushing did not call upon Frederick Halsey to testify. This may have been because his views on the subject were already so well known that, with a limited amount of time available, the opposition forces preferred to confront the Committee with new opponents. It may also have been, however, that some of Mr. Halsey's colleagues found him a shade too abrasive to be helpful to the cause. As Henry R. Towne had put it in 1904: "I regret to say that some of his statements are intemperate, although the facts are correct."

The fact that the composition of the Committee on Coinage, Weights and Measures had changed over the years is also worth mentioning. Mr. Shafroth had resigned in 1904. This left only Chairman Southard on the Committee to carry the main burden of supporting the proposition. Others on the Committee did appear to favor the metric bill, but none of them was as ardent or as knowledgeable an advocate as Mr. Shafroth had been. On the other side of the question, Mr. Dale had acquired a formidable ally on the Committee in the person of Congressman W. C. Lovering from his home State of Massachusetts. In private life, Mr. Lovering had been a textile manufacturer, so he and Mr. Dale were generally of one mind on the metric question.

Not surprisingly, very little new "evidence" was put forth at the March-April 1906 hearings, and most of the arguments used had long since been heard from both sides. The most significant testimony came from Congressman Littauer, the bill's sponsor, who verified for the first time, that the "entering wedge" theory was well-founded:

> "It is very plainly stated here that no one will be compelled to use the metric system of weights and measures unless he has dealings with the Government; there is no obligation whatever upon any private individual to use the system unless he so desires. I want to be perfectly frank, however, and I will state right here that the only object in making it compulsory upon the Government is so that the people throughout the United States may begin to get some practical experience, or have examples before them, of the practical uses of weights and measures, in order that at some future

day they may be able to determine whether or not they will demand their compulsory use throughout the country [142]."

Mr. Littauer also had a few words to say about the opponents of the bill:

"[T]here is a sort of propaganda of opposition around about, that comes from secretaries of associations . . . [T]he manufacturers' association under the head of Mr. Cushing, and led largely, I believe, by one or two other gentlemen who appeared here, are the active opponents of the metric idea throughout the country and have been so for a number of years. They have instigated the resolutions passed against it . . . [B]ut the mere fact that the system is opposed is one thing and reasons given for the opposition are another thing. I feel that if they came here with valid reasons we would have to meet them [143] . . ."

Mr. Littauer's opinion of the opponents' objections notwithstanding, it is possible to discern the development of a logical and consistent line of reasoning for their position by stripping of its surplus rhetoric all of the testimony given between 1904 and 1906. This line of reasoning went as follows:

1. An Act was passed in July 1866 making use of the metric system legal. Since anyone who wanted to was free to use the metric system, new legislation would either have to be compulsory or it was not needed. If it would be useless legislation, the need to proceed further vanished on the spot.
2. If the bill would be compulsory *only* on the Government, its sole effect would be to place the Government on an entirely different basis of weights and measures from the people which it was supposed to be governing. Since this was hardly desirable, the legislation must have been an "entering wedge," a device for making it compulsory on everyone else.
3. If the legislation was to be compulsory for everyone, then either the customary standards would have to be abolished or people would have to pay a penalty for using them. The notion that conversion to the system could be achieved by simply relabeling a product, i.e., expressing in metric units the size or dimensions of a product made according to customary engineering standards, was a pipe dream because: (a) conversion from English to metric labels would be expensive and time-consuming since metric-English equivalents were generally odd numbers rounded off to a couple of decimal places (e.g., 1 inch=2.54 centimeters); and (b) this would be "false conversion" anyway or, more accurately, not conversion at all. It would simply be dual labeling while still utilizing customary weights and measures. Why not call an "inch" an "inch?" Neither would adoption of the metric system be achieved, the opponents claimed, by establishing penalties for the ordinary use of customary standards. The Government had no right under the Constitution to

pass such a law, could not enforce it, and would never be able to get rid of the old standards that way. Therefore, the clear intent of the bill must have been to make use of the system compulsory by banning the customary standards to whatever degree the Congress had legal authority to do so.

4. If this were the case, the opponents were prepared to attest to the results that might be expected: resistance; confusion; the expenses of product redesign, retooling, and replacing machinery before the end of its useful life; investment in dual stocks of spare parts and in employee retraining; and a very long transition period. To be added to this list was the fact that the metric system was deemed not to be as well-suited as the customary system for certain applications, and the fact that manufacturers could see no advantage to making the change. In their minds, this left as the only justification for passing the bill the reasons that: (a) scientists wanted it, and (b) some other countries (although not the United Kingdom) had accepted it. They felt that the price was too high to pay for the meager benefits the U.S. would get from the change, and so they actively urged the defeat of the proposed legislation.

On their part, the advocates of the system, it must be said, did very little to help their own cause. Their case was not based on either the positive advantages to be gained by "going metric" or the possible adverse effects of not doing so. Instead, they continued to cite the superior attributes of the metric system as a reason for accepting it, they placed a great deal of emphasis on the "world trend toward metric adoption," they dogmatically asserted that its eventual use was inevitable, and they spent the remainder of their time trying to disprove their opponents' arguments. In the latter objective they were not successful, and could never have been so, for the opposition was just as certain that its stand was the correct one.

By 1907 a monumental impasse had been reached. In a last, futile attempt to break the deadlock, Henry R. Towne, an opponent of the legislation in the form in which it had been introduced, proposed that a commission be created to investigate and report on the whole subject [144]. It would consist of 15 individuals, representing the major industries and professions, and it would also collaborate with the British Government, if they so desired, to reach a mutual agreement concerning alteration or abandonment of the customary system. To this end a bill was introduced in Congress on May 18, 1906,[22] by Mr. Lilley of Pennsylvania. No action was ever taken on this bill.

The fate of the Littauer bill was more definite. As reported in the Toledo (Ohio) *Blade*, Mr. Southard's home-town newspaper, on April 27, 1907:

"By a vote of 4 to 7 the Committee of Coinage, Weights and Measures [sic], of which representative Southard is chairman, refused to report favorably the bill providing for the use of the metric system by the government. Those who voted for the bill were

[22] H.R. 19469, 59th Congress, 1st Session.

> Southard, Dresser of Pennsylvania, Knowland and Sullivan of New York. The vote was taken after an extended hearing lasting through two sessions [145]."

With this action proposed metric legislation came to a halt for about a decade. It is not necessary to look very far to find the main reason—Chairman Southard was defeated in his bid for reelection to the 60th Congress. With only limited support for the idea in Congress, with an aroused opposition ready to pounce on any new proposal, and with the accumulated discouragement and frustration from 10 years of unsuccessful advocacy, it is easy to understand why the pro-metric forces were willing to withdraw temporarily from the field of battle. Adding to their list of miseries was the news of the latest development from Great Britain—on March 23, 1907, the House of Commons rejected a proposal to provide for introduction of the metric system [146]. This, apparently, was the last straw. The issue would be raised again from time to time over the next few years in a trade magazine or a professional journal or two, but nothing approaching a serious metric adoption campaign would develop again until America was enmeshed in World War I.

I. RECAPITULATION

Between 1890 and World War I, a period which ended about 1907 as far as effective agitation for metric adoption was concerned, the history of the metric system in the U.S. entered a new era.

Many of the arguments both for and against adoption of the system had not changed from those which had been put forth during earlier periods. Certainly, none of the old arguments had been discarded, they had simply been rediscovered, cast in a new light, and given a different priority. During this period, for example, arguments concerning the intrinsic merits and superiority of the metric system were much less important than they had been to the participants in previous eras. Instead, the debate centered on the question of feasibility—could the change to the metric system ever be legally and satisfactorily accomplished?

This question was occasioned by the blossoming of the "age of industrialism" in the United States. With the growth of mass production and the realization of the full industrial potential of interchangeable parts came the need to agree upon standard sizes and dimensions for the finished products and any components that went into it. This need for standardization was accentuated by the fact that component parts were obtained in many cases from independent suppliers by the manufacturer who turned out the final product. To serve the need for standardized parts manufactured with precision to very close tolerances, a great deal of time and money was invested to develop uniform industrial standards. This effort had been an unqualified success but, unfortunately for metric advocates, most of the end results had employed the units of the customary system of weights and measures. The people who had hard cash invested in this system, the manufacturers, and the people who had created and strove to maintain it, the mechanical en-

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gineers, were not about to stand idly by and allow another measurement system to be substituted which they believed would destroy their good efforts.

The ruination of American industrial standards was the farthest thing from the metric advocates' minds. They continued to be concerned that the U.S. would be left behind in the rush to adopt the metric system that was sweeping the world. All of the major European nations had accepted the system, at least for official governmental purposes, and even our Latin-American neighbors had seen fit to welcome this metrological reform. The least the U.S. could do, it was thought, would be to adopt the system within the Government so as to put us on an equal footing with the rest of the world. After that was done, people would be sure to recognize the advantages and the desirability of extending the use of the system into other areas. Besides, the Congress had never exercised its authority "to fix the standard of weights and measures," and this oversight was long overdue to be rectified.

And so, in 1890, there began a succession of attempts to encourage Congress to finish what it had started in 1866. The Pan-American Conference of that year resulted in a series of recommendations on the matter from Secretaries of the Treasury. In 1893, by an administrative action, the metric standards we had received as a result of the Treaty of the Meter were declared to be the Nation's "fundamental standards." Three years later, in 1896, a bill to require Government adoption of the metric system narrowly eluded all efforts to pass it in the House of Representatives and the real campaign began. In succeeding Congresses until 1906 there was always a similar bill pending, at least in the House. Hearings were held in 1896, more extensive hearings were conducted in 1902, and the most extensive hearings ever were held over a 3-year period from 1904 to 1906. In all but 2 years between 1896 and 1902 (1899 and 1900) the Committee on Coinage, Weights and Measures issued favorable reports. After 1902, they issued no more on the metric system until 1937. In contrast to earlier and later eras in the history of the metric system, the halls of Congress were the primary focus of this era. This was, perhaps, due to the fact that Congressmen were among the leading supporters of metric adoption during this period. Chairmen Charles Stone and James Southard of the Committee on Coinage, Weights and Measures were faithful believers in the necessity of the proposed action, as were Congressmen Denis Hurley, John Shafroth, and Lucius Littauer. Whether or not it is relevant to this issue cannot be determined, but all were members of the Republican Party. Another avowed proponent of metric adoption was Dr. Samuel W. Stratton, first director of the National Bureau of Standards, which was created in 1901.

The first serious opposition to the proposed reform materialized at a December 1902 meeting of the American Society of Mechanical Engineers. Its leading voice was Frederick A. Halsey, the associate editor of an engineering publication. He was soon joined in his fight by Samuel S. Dale, the editor of a textile publication, and together they authorized the leading book on the subject of this period, *The Metric Fallacy*. The collaboration of these two individuals helped to crystallize the opposition and, at the 1904-1906 hearings, some of the Nation's leading manufacturers appeared to oppose the bills under consideration. The resistance was particularly strong among machine-tool manufacturers, but spokesmen for other leading industries were also dead set against the metric system. Their will prevailed.

By 1907 this series of metric proposals had run its course. The attempted reform of our system of weights and measures had not been forthcoming, and the advocates of it were once again forced to await a more propitious opportunity. When they thought that time had come, they would find the opponents waiting for them.

VI. THE GREAT METRIC CRUSADE (1914-1933)

The unmistakable failure of the 1906 drive for metric adoption and the concurrent defeat of Congressman James H. Southard at the polls completely undermined the base of support which pro-metric forces had built up in Washington. Consequently, the movement again went "underground" for awhile, surfacing on the eve of America's entry into World War I. The next campaign was launched in 1916, blossomed after the armistice, reached peaks of furious activity in 1921-22 and 1925-26, and burned itself out in the early years of the great depression. During these years the metric issue became a full-fledged public controversy. Nurtured by an entirely different sort of campaign than any that had gone before, the metric movement and the opposition to it became almost totally "institutionalized" in that the battles were fought by organizations and interest groups rather than by individuals alone. The organizations that were formed and the methods they used to attain their objectives were also different from those of an earlier day, although there were some striking similarities in the arguments they advanced.

The main target of both pro- and anti-metric interests was still proposed legislation designed to increase U.S. use of the metric system. The principal efforts of the participants in the process, however, were directed toward capturing public opinion, hoping to influence the legislative process in this way. In essence, this great metric crusade became a propaganda war. An avalanche of "irrefutable" factual material was presented as proof of the veracity of conclusions that were, more often than not, diametrically opposed by those favoring the other side of the question; emotional and irrational appeals were thrown in for good measure; personalities and individual motives frequently were dragged through the mud; and the use of superlatives and exclamation points became the dominant style in the printed literature on the subject of metric adoption.

It was not that such an approach was necessitated by a change in the character of the idea itself or by the radical nature of the specific legislative proposals advanced. This aggressive style was simply in keeping with the prevailing spirit of the United States in the decade following the First World War. In the words of historians Samuel Eliot Morison and Henry Steele Commager:

> "[The decade was] characterized by political and business corruption, decline in liberalism, apathy toward reform, and an ardent nationalism that took repressive and intolerant form [1].
>
> Everywhere there was a profound distrust of reason, and as men lost faith in reason, they ceased to use the discredited instrument. They lost faith, too, in the values that had long been taken for granted, and even, it would seem, the capacity to believe in the existence of values. There were no grand ideas, only a sophisticated rejection of ideas; there was no faith, only renewed superstitions masquerading as faiths. For all its cascading energy the age was negative rather than affirmative, incontrovertible in repudiation but feeble and unconvincing in its affirmations. Never before had so many men known so many excellent arguments for rejecting the heritage of the past; seldom did a generation bequeath so little that was permanent, so much that was troublesome, to the future [2]."

During these years the real metric issue remained what it had always been. The merits of the system and its widespread international usage were pitted against the lack of a clear need for it and the possible impact upon the U.S. of making the change. In this period, however, the issue emerged as a much more black-and-white proposition than it had at any other time. The two sides of the question were taken to be mutually exclusive, and the differences between the factions supporting each became irreconcilable. Both sides employed all conceivable arguments with little regard for their validity. The campaign was not fought intelligently, but it was certainly rendered interesting by this state of affairs.

At least 43 pieces of legislation having some bearing on the metric system were introduced in Congress between 1914 and 1933. Only about half of these were bills that openly called for adoption, extended use or a Government study of the metric system. At least 18 bills were proposed whose main provisions dealt with some aspect of weights and measures usage other than an official U.S. system but which contained wording that was interpreted as an attempt to sneak the metric system in by the back door. The remaining legislation, all triggered by the zeal of a single individual, would have established a revised and decimalized English system as the official basis for U.S. weights and measures. No single, dominant legislative strategy was represented by the proposals of this period. Metric advocates were willing to settle for almost any Congressional action that would extend the use of the metric system by any segment of American society. Conspicuous by their absence, however, were legislative proposals providing for Government use as an initial step, to be followed later by a general extension of the metric system to other affairs. Apparently the supporters of the metric reform during this era wished to avoid repeating their 1896-1907 experiences with such proposals.

For all the legislation advanced between 1914 and 1933, only two sets of hearings were held—one on the Senate side in 1921-22 and one on the House side in 1926. No committee reports were issued. This was in sharp contrast to the previous campaign when hearings and reports had served as the principal mechanism for placing the issue before the public. Perhaps the novelty of public hearings had worn thin by the 1920's (open committee hearings as a standard Congressional policy were an innovation of the early years of the 20th century) or perhaps legislators simply were determined to avoid becoming embroiled in a pitched battle over a technical subject about which they knew little. Whatever the reason, the hearings during this era served mainly to provide a periodic test of strength for the two factions. Although they were not especially productive of illuminating results, these hearings did underscore the impossibility of reaching an acceptable compromise on the issue, and the committees' repeated failure to favorably report a metric bill eventually gave the opponents a victory by default. The 1921-22 hearings marked the first formal consideration of the question by the U.S. Senate since 1866, and are noteworthy for that alone since the House, which had chartered a standing committee to oversee weights and measures legislation, did not take up the issue again until 1926 in spite of repeated requests to do so.

Aside from the Congress, the cast of characters participating in the metric controversy during this era included three special-purpose interest groups, the National Bureau of Standards and its directors, a few newspapers, magazines and trade journals, and a handful of concerned individuals not irrevocably affiliated with any group. Two interest groups were active in agitating for metric adoption. One was the Metric Association, a group much like the earlier American Metric Bureau in its doctrine and membership. The other was started as the Foreign Trade Club of San Francisco, and was known at various times as the World Trade Club, the World Metric Standardization Council, and the All-America Standards Council. In spite of the names adopted, this organization was, in reality, little more than a fancy publicity campaign carried out by less than a half-dozen men. Even though they were quite different in character, both organizations sought the same goal and each supplemented the other's efforts in a variety of ways.

On the anti-metric side of the ledger the forces were led by the American Institute of Weights and Measures. The Institute was conceived and founded by Frederick Halsey and Samuel Dale. Although both men took an active part in the Institute's efforts, at least for part of this era, it was the financial and political support of a significant number of American manufacturers which led to its success. It was also able to secure assistance, in the form of publicity, from a number of periodicals, most notably the *American Machinist*. The American Institute of Weights and Measures was a vigilant and effective opponent, successfully meeting each pro-metric challenge (real or imagined) until the need for such an organization gradually ceased to exist.

The National Bureau of Standards continued to be a favorite target of metric opponents during this period. Its directors were accused of various prejudicial policies and breaches of decorum unbecoming an officer of the Government in spite of their constant denials. While not all of the opponents' allegations were totally unfounded, they were certainly exaggerated. The statements made by Bureau officials during these years were not nearly as avowedly pro-metric as they had been during the previous campaign, but most Bureau attempts to assume a neutral position were viewed by detractors as simply efforts to mislead Congress and the public. Perhaps resulting from a theory of guilt by association, the National Conference on Weights and Measures, created by the Bureau in 1905, also came under attack during these years. Because NBS was located in the Department of Commerce both sides also courted successive Secretaries of Commerce, with varying degrees of success, hoping to influence the Bureau's activities in some way.

In the end (which came with the acute financial and social problems inflicted by the depression) the metric system never did get adopted by legislative mandate. Whether it ever had an even chance of favorable action during this period is debatable, but it became all too apparent at an early stage that the issue was too controversial to be settled by simply enacting a law. This situation did not deter the enthusiasm of the men who were bent on bringing about the metric system reform, however, and the ensuing crusade resulted in the most intense period of metric agitation in the entire history of the movement.

A. THE PARTICIPANTS

One of the outstanding features of the great metric crusade was a return to the strategy of group agitation. This strategy had not been employed by either metric advocates or anti-metric interests since the campaign of the 1870's and 1880's. By 1915, however, generally-accepted practice made the times ripe for a revival of it. The rise to prominence of interest groups of all types was an often-discussed phenomenon of American politics during these years. As the *Saturday Evening Post* reported in 1920:

"A new crop of special interests has come to town to take the place of the old furtive, sly, pussy-footed special interests. They are not gum-shoers; anything but. They try to make as much noise as possible. Far from avoiding publicity, the chief weapon in their armory is their publicity agent. They seek publicity. They crave publicity. They manufacture publicity. They swat the tomtom, sound the hewgag, and make continuously loud outcry, saying:

'This is the panacea. This is the cure. This is the remedy. This is the stuff to give 'em [3].'"

The cause of such special attention was the rapid appearance (and sometimes disappearance) of hundreds of new and unknown interest groups in the immediate postwar years. An in-depth study of such groups that was made by political scientist E. Pendleton Herring in 1928 [4] provides much useful insight into the character and operations of the three metric groups of this era since the groups conform, in general, to the stereotype outlined by Herring's findings. First of all, Herring found that there were two broad types of interest groups: those that worked for the direct interests of the membership (craft organizations, businessmen's associations, professional associations, farmer's organizations, and the like) and those that were concerned with what they believed to be the welfare of the "other fellow" (reform associations, international movements, and so on) [5]. Concerning the forces of organized reform and internationalism, Herring observed:

"The number and variety of associations of this nature existing in the country is legion. Very often they are transitory and flourish during the agitation of a particular issue, only to die out when the crisis is past [6].

These societies, both in their relations with the public and with the government, are interested in formulating sentiment or expressing opinions upon such matters as Americanism, patriotism, internationalism, pacifism, radicalism, communism, immigration or national defense. They differ among themselves as to the attitude they take upon these questions and as to the problems upon which they place chief emphasis. Nevertheless, the viewpoints of these associations, may be divided into two fairly definite categories. The one class is nationalistic, conservative and inclined to follow traditional policies. The other takes a liberal viewpoint, advocates internationalism, and expresses a desire to change the *status quo*. It naturally follows that between these divisions there is little in common. In fact, actual ill-feeling and a very deep distrust exists in some cases [7]."

It would be difficult indeed to find a more accurate conceptual description than this of the interest groups involved in the metric question during this era. Transitory, with one exception (the Metric Association, which is still active today); hopeful of arousing sentiment or shaping opinion; nationalistic versus international in outlook; and conservative versus liberal in attitude—all of these characteristics may be attributed to the three metric groups that flourished in the 1920's.

Herring also drew conclusions concerning the true strength of some such organizations which indicated that certain metric groups were typical in this respect, too. Some societies, he found, attempted to create the impression that they were large, powerfully-backed, and spoke for a great many voters when in fact the group consisted of little more than an office, an executive secretary and a card-file index. The two pro-metric organizations, at least, fit this pattern for most of the years during this era.

Herring's most interesting findings, however, were those that dealt with how these interest groups operated. Observing that the most effective lobbyists were those that kept watch over developments at the capital but spoke though the membership at the grassroots level, he stated that lobbyists did their real work at committee hearings:

> "These are the men with the facts at their command. They are competent to discuss with authority technical questions which are enigmas to an average congressman . . . . [H]e knows the interests of his organization and he knows the members who can give the most useful information to the congressional committee. The day of the hearing the lobbyist has his witnesses and his briefs ready to present. He is truly a member of the 'assistant government' [8]."

Herring also agreed with the *Saturday Evening Post*. Propaganda, he felt, was the strongest weapon in the lobbyists arsenal. He attached no derogatory connotation to the word but used it to mean simply "the instrument that helps mold public opinion in the form the interested party desires [9]." His observations concerning propaganda methods are a nearly perfect description of the tactics employed by metric interest groups of that day:

> "One method that is used by practically all the national associations is the publication of a journal recounting the activities of the organization, giving the point of view of the officers, telling of future plans, and emphasizing in a lively and attractive form the main purposes of the organization . . . To attempt to describe the other types of publications is to risk drowning in a sea of paper. It is to be computed by the ton. Pamphlets innumerable, on every conceivable phase of every conceivable subject, are sent far and wide; reprints of speeches and articles bearing upon the work of the association are distributed; periodical releases are prepared and sent to the newspapers; entire books are written; research work is undertaken and the results published in elaborate and expensive form by many of these organizations. . . . . Workers are sent into the field, to organize clubs, to give lectures, to hold meetings, and to undertake campaigns of education lasting for a protracted period [10]."

Compared with the giant associations—the Chamber of Commerce, the Grange, the National Association of Manufacturers, and labor unions—the efforts of metric groups were puny and unimportant. Still, they managed to inflate the issue to a disproportionate size and they were, in all respects, as serious as the efforts of the larger groups. The effectiveness of these activities is a different question. According to Herring, all lobbyists, even those representing major segments of society, were a favorite complaint of Congressman (one such gentlemen even unburdened himself in the *Congressional Record,* lamenting: "They are becoming as numerous as the lice of Egypt. A stone casually thrown in the streets of the city would probably hit half a dozen of them [11])." In all, Herring estimated, there were only 60-100 interest groups in Washington that could be considered effective [12]. Judging by the attitudes of Congressmen, made public at metric hearings, it is evident that the metric interest groups were not among them. Nevertheless, the metric agitation of the era was lively, colorful, and by no means doomed to failure from the very beginning.

1. THE METRIC ASSOCIATION

The Metric Association, founded on December 27, 1916, as the American Metric Association, was a modernized version of the American Metric Bureau in many ways. Its goal was to secure the general use of metric weights and measures in the U.S., and although it favored legislation that would have accomplished this goal, the Association's main interests lay in the direction of promoting the introduction of the system through educational and professional channels.

Director Samuel Stratton of the National Bureau of Standards played an instrumental role in creating the Association. In 1916 he persuaded Dr. Henry V. Arny of Columbia University to convene representatives of leading American Associations to consider the best methods of furthering the metric cause [13]. After the Metric Association was formed, Dr. Stratton was elected to the executive committee, an office which he retained until his death in 1931.

George F. Kunz, a gem expert, president of Tiffany's, and a mining engineer, was elected the Association's first president. Others instrumental in founding the organization included Fred R. Drake, a wholesale grocer, Arthur E. Kennelly, an electrical engineer and Harvard professor, and William Jay Schieffelin, a chemical manufacturer. Howard Richards, Jr. was the organization's active secretary. Within a few years Frederic L. Roberts had become the Association's treasurer, and he, along with Mr. Richards, served as the leading spokesmen for the group during most of this era.

The Metric Association never became a wealthy group. During its first year it operated on a budget of only $3,900. This amount gradually increased to a peak of about $8,100 in 1925, when it began to decline again. In 1931 the group's income reached a low of $3,400 and all activities (and dues) were suspended for several years because of the depression.

Individual contributions and subscriptions to the Association's quarterly journal, *Measurement,* provided most of this income. Individual dues were $2 per year, corporation dues were $5 a year, organization dues were $10 a year, and sustaining memberships sold for $100 a year. Some firms and national organizations were loyal members, although these were few in number. They included the American Association for the Advancement of Science (with which the Metric Association affiliated itself), the American Chemical Society, the American Drug Manufacturers' Association, the National Canner's Association, and the American Pharmaceutical Association.

In spite of the group's limited resources it managed to share the costs of a Washington representative, W. Mortimer Crocker, with the other pro-metric group. It also employed a small staff at headquarters in New York which turned out annual reports, circular letters, an occasional pamphlet, and the quarterly journal of the Association. Annual meetings were held at the same time and in the same city as the meeting of the American Association for the Advancement of Science. The highlight of this yearly affair was generally a "metric dinner" with an eminent guest speaker.

The Association's main function during this era was serving as a clearinghouse for pro-metric reports, articles and activities. Representatives of the Association were always on hand to testify at congressional hearings and to address other appropriate gatherings, such as the National Conference on Weights and Measures.

One activity that the Association undertook was particularly reminiscent of the efforts of the defunct American Metric Bureau. For a time the Association attempted to sell various metric-related items—charts, rulers, a lapel pin, a crossword puzzle, and other paraphernalia. Unlike the ambitious program of the American Metric Bureau, however, the Association's effort was only a sideline and was discontinued after a few years. The idea may even have been contributed by that metric supporter of long standing, Melvil Dewey, who was a prominent member of the Association, although largely an inactive one due to his advanced age.

Among the publicity gimmicks employed by the Association at this time was the establishment of a "Metric League." Membership in the league was absolutely free. To join it a person was only required to sign the following statement (which was pre-printed on a postal card addressed to the Association's headquarters): "It is our/my purpose to use the metric weights and measures whenever feasible [14]." Begun in 1922, the league numbered only about 500 members by 1927—perhaps the most accurate indicator of the real depth of support for the metric system during these years.

The overall plan of action adopted by the Metric Association was embodied in a mnemonic device—SUCCESS:

"*Secure* the cooperation and membership of other associations, firms and individuals. The best members come "won" by one.

Use metric weights and measures in homes, offices, factories and stores.

Confer with local leaders and insure right metric methods by having the booklet 'Metric Weights and Measures' used in factories, stores, in technical and other schools.

Carry on a local Section of the American Metric Association.

Enthuse the managers and editors of technical journals, magazines, and newspapers, and keep them supplied with metric campaign copy.

Show manufacturers of foods, drugs, etc. that including the weight in grams on all labels helps sales to Americans using the metric system, appeals to those born in metric countries, and renders American products available for export trade.

Stimulate private and public discussion, debate and congressional action on behalf of the metric movement [15]."

Unfortunately for the Metric Association, neither their finances nor their membership ever grew large enough to permit extensive implementation of this plan. This lack of support was compensated for to some degree by the appearance in 1919 of a pro-metric organization operating out of San Francisco. By joining forces when the occasion called for it, the two groups managed to create an appearance of widespread popular support for the metric cause.

2. THE WORLD TRADE CLUB AND ITS SUCCESSORS

In March 1919, a flood of literature extolling the virtues of the metric system began to emanate from San Francisco under the masthead of an organization calling itself the World Trade Club. The Foreign Trade Club of San Francisco, a *bona fide* association, was claimed to be the parent organization for the metric group. In reality, however, the World Trade Club was not a club at all but was, rather, the cloak for a publicity campaign whose sole purpose was to secure legislation adopting the metric system in the U.S. For this reason no financial data or membership figures were ever publicly released by the group. Most of the other trappings of organized metric activity were also lacking in the World Trade Club's campaign, including slates of officers, annual meetings and a periodic journal of activities. The name "World Trade Club" had been assumed by the organizers of the campaign in order to leave the impression upon readers of its literature that there was a substantial movement afoot to promote metric adoption. In later years other names would be deemed more suitable for these purposes. In 1920, for example, the name World Metric Standardization Council was adopted and 4 years later it was changed again, this time to the All-America Standards Council. Regardless of the name being used, the main individuals involved remained the same. The entire campaign, which lasted only 8 years from beginning to end (1919-26), was financed in large measure by one man and was carried out by a small advertising firm, also under the direction of a single individual.

The chief backer of the San Francisco campaign was a wealthy manufacturer by the name of Albert Herbert. Mr. Herbert's desire to avoid having the campaign linked to his name gave an air of mysteriousness to the whole affair and led the opponents of metric adoption to refer to him as "Mr. Z." They were fond of claiming that Mr. Herbert had donated more than $500,000 of his personal fortune to this cause as a hobby and, while the amount may have been slightly exaggerated, he did provide at least $80,000 to carry out the work [16]. Mr. Herbert's wealth had been accumlated as a result of his business ventures. For most of his life he had been engaged in the manufacture of rubber textile products, serving as the president and director of a variety of firms in this field. Mr. Herbert was born in England in 1856, had emigrated to the U.S. in 1880, and had retired to San Francisco by the time of this campaign [17]. He had apparently become an advocate of metric adoption while serving as Chairman of a metric committee of a manufacturers' association in 1898 and had indulged his interest over the years by making substantial financial contributions to organized metric efforts in both the U.S. and Great Britain. His motivation for this was apparently a desire to increase foreign trade and a general interest in international reform movements. For example, he was a supporter of the movement to establish "universal English," an artificial language, on an international basis and he utilized this language in most of his personal correspondence. When Albert Herbert died in 1927 the San Francisco-based campaign was left without firm financial backing and it soon folded.

Because of Mr. Herbert's insistence upon anonymity, the real work of the campaign had to be done by someone else. Mr. Herbert chose a young technical editor named Aubrey Drury to organize and conduct the activities of the World Trade Club. Whatever Mr. Drury's original feelings were about the desirability of metric adoption, he soon became personally dedicated to the cause and set about promoting it with fervor and enthusiasm. What may very well have started out as a simple business proposition with Mr. Drury eventually developed into a life-long interest. Even after funds for the work ceased to be available, he continued to author pro-metric articles and editorials, publishing them in whatever way he could. These problems did not exist in the early years of the campaign, however, and Aubrey Drury was able to generate a large quantity of pro-metric propaganda and employ nearly every scheme in the book in an attempt to accomplish his goal.

Reduced to its simplest form, the World Trade Club's campaign had two aspects to it: influencing public opinion and influencing Congress. Although the purpose of the first was to make the second one easier, each was done in a different way.

To capture public attention and sway it to the metric cause, an intensive propaganda effort was mounted. In 1919-20, the peak years of this activity, pamphlets, circular letters and "news releases" were issued by the dozen. For a short time a periodical entitled the *Weekly Metergram* was published. To attract attention, pamphlets were given titles such as *Keep the World War Won* and *Metric Units to Unite the World*. In anticipation of the opponents' arguments a series of pamphlets was also produced which asked, and purported to answer, such rhetorical questions as: *Who Urges Meter-Liter-Gram? Who Opposes Meter-Liter-Gram? What Will Metric Standardization Cost?* and *Who Suffers?* To counter the opposition's assertions that the World Trade Club was merely a "front" organization, a booklet was issued entitled *An Evening at the World Trade Club* which gave an account of a very well-attended metric dinner. The pamphlet ended on the following note:

> "The meeting closed. As these leading merchant-manufacturers were leaving they were still talking among themselves on the interesting subject of meter-liter-gram. One and all, they felt that many intensely suggestive aspects of the question had been brought before them. The meeting, they decided, had been a significant

one for all who had the vision to see the possibilities of future development in world trade.

In groups they passed into the balmy atmosphere of a perfect San Francisco night. As they made their way homeward, the stars shone out, gleaming with incandescent brightness in a setting of richest ethereal azure—a beautiful California evening sky [18]."

This flowery pamphlet did not go unnoticed at opposition headquarters. In a subsequent issue of their own journal, the American Institute of Weights and Measures had this to say: "We don't know whether there was any 2.75 on board or not; but one thing we do know—the 'ethereal azure' is the natural habitat of the metric visionary [19]."

The pinnacle of the World Trade Club's literary achievements was reached in 1922, when a full-sized volume of more than 500 pages was published. Compiled by Aubrey Drury and entitled *World Metric Standardization: An Urgent Issue,* this volume was made up of reprints of all earlier pamphlets and was, figuratively speaking, a "shopper's guide to favorite metric arguments, personalities and literature." The substance of this book will be discussed in a subsequent section of this chapter.

Other devices were also employed in the organization's attempt to mold public opinion. To demonstrate the position of the United States in relation to the rest of the globe on this issue, for instance, maps were devised "showing well-nigh worldwide use of the metric system." By placing the U.S. in the center of the map and by coloring it bright red, this country was made to seem even more alone in its adherence to English weights and measures than we actually were. To counteract the longstanding objections to the foreign origins and unfamiliar nomenclature of the metric system, two things were done. In the first place, James Watt, the eminent Briton, was put forth as the "inventor of the metric system." This claim, which was based upon a single sentence of an encyclopedia article that Dr. Stratton had written, was practically fraudulent. All that James Watt had ever advocated with respect to weights and measures was the use of a decimalized English system based on a single unit of length [20]. The second scheme involved a plan whereby the names "world yard," "world quart," and "world pound" would be substituted for the actual metric names. The values of the units and the standards for them, however, would not differ a bit from those known elsewhere as "metric." In yet another attempt to attract the public's attention a prize of $1,000 was offered to the individual who could coin the best single word denoting the combined nations of U.S. America and Britannia. Hundreds of suggestions were received as a result of this offer and the word "Unitannia" was eventually settled on.

The World Trade Club was also concerned about the charges that only "closet philosophers and theorists" favored metric adoption. To neutralize this idea, Drury compiled lists of names of hundreds of "practical men, urging meter-liter-gram." One of his most frequently-used bits of testimony was a letter from General John J) Pershing. As cited by Drury, the letter went as follows:

"The experience of the American Expeditionary Forces in France showed that Americans were able readily to change from our existing weights and measures to the metric system. I think the principal advantages of the metric system are summed up in the fact that this is the only system which has a purely scientific basis. Not the least advantage of the fact that the metric system is based on scientific principles is the facility which that system gives to calculations of all kinds, from the simplest to the most complex.

I believe that it would be very desirable to extend the use of the metric system in the United States to the greatest possible extent [21]."

This quotation was accurate, as far as it went, but it was not all of General Pershing's letter. The rest of it read:

"but I can readily see that there would be many practical obstacles in the attempt entirely to replace our existing system by the metric. These obstacles have to do especially with manufacturing plants and with existing records of all kinds. I am not sufficiently familiar with the technical phases of the question to be able to say whether or not such obstacles might be overcome, and as a consequence I would prefer not to be quoted as advocating the replacing of our present system by the metric system [22]."

If pronouncements concerning the metric question that were made by other notable individuals received a similar editing at Mr. Drury's hands, and it is probable that such was the case, they must be taken with a grain of salt.

The object of all this activity, of course, was to induce favorable Congressional action. Mr. Drury and his associates had little patience to spare for educational campaigns and efforts to secure commitments to using the system from a few isolated firms. They appreciated the publicity value of successful work along such lines but were happy to leave that chore for the Metric Association to do. Drury's goal was to get a law passed that would compel outright conversion to the metric system. He was willing to accept a lesser substitute, providing that it would achieve the same results in the end, but only in the interests of political expediency.

The strategy for accomplishing this goal that was settled on by Drury and W. Mortimer Crocker, the Washington legislative agent for the pro-metric groups, was very ambitious and a little naive. The plan was to get as many bills as possible introduced in each session of Congress in both the House and the Senate. In addition, Drury hoped to have such bills referred to several different committees and get hearings scheduled before each one. Furthermore, he wanted the sponsors of metric bills to be drawn from the Congressional elite, the most powerful and prestigious Representatives and Senators that could be persuaded to introduce such bills. Particular targets included the Speaker of the House, senior party leaders, floor whips and committee chairmen. Drury also urged Crocker to carry out an extensive campaign of "education" among as many elected officials as could be cornered. Due to his West Coast location, Drury had to rely heavily on Crocker to handle the Washington affairs, and Crocker performed yeoman's service in trying to do everything that both groups asked of him [23]. Even with the aid of expert advice from some of the staff at the Bureau of Standards [24], however, the scope of the job outlined was just too broad for one man.

Mr. Drury's own part in the Congressional drive was to arouse interest in the subject among Congressmen. To this end a massive petitioning campaign was initiated. Postal cards addressed to "Federal Government, Department of Commerce, Bureau of Standards" were issued by the thousands [25]. On the reverse was printed: "The undersigned is in favor of legislation that will bring about the exclusive use of Meter-Liter-Gram by the United States of America," and the petitioner had only to enter his name, address, vocation and the date. A similar card was prepared for use in Great Britain. A variation of this same theme was also tried. A form letter was provided to people on the World Trade Club's mailing list and sympathizers were asked to send them to their Congressmen and Senators. If raw numbers were any indication of success, the petitioning campaign was one of the most worthwhile ventures that was undertaken during this period. In all, over 100,000 petitions were received and many Congressmen reported that they had heard from constituents on this matter. Whether or not these petitions carried any weight with the Congress is a debatable subject. They certainly were not enough to carry the day.

Mr. Drury's other activities on the Congressional front included the practice of sending telegrams to "key legislators" urging support for metric bills and attempting to persuade important Cabinet members to take a stand on this issue (especially Commerce Secretary Herbert Hoover—who never did comply). Drury also laid grand plans for dazzling the committees once hearings were scheduled. He hoped to be able to marshal a parade of "star witnesses" to testify on behalf of the metric system. In particular, he had in mind such eminent individuals as General Pershing, Thomas Edison, Henry Ford, Herbert Hoover, and Franklin D. Roosevelt. This, too, was not to be.

The main problem, of course, was that the organization lacked sufficient influence to achieve such impressive results. Other things which hindered the attainment of the group's objectives were noted in a 1920 memorandum written by Aubrey Drury's brother, Newton Drury. It was a very frank and suprisingly accurate assessment of what had either been done wrong or not done at all. Specifically, he mentioned:

"(1) *Lack of a definite plan of campaign*. This has resulted in waste and duplication of material, in needless repetition, in ineffectual statements because of the haste in which they have been issued, in too great emphasis upon some points and too little upon others, in thoroughly covering some elements of the population and neglecting others almost entirely. One element largely overlooked has been the agricultural, among the largest classes in our population.

(2) *Scattering fire*. Collateral issues, like renaming Britannia and America, the use of Unitannia, the use of simplified spelling, use of arabic continental dating, pleas for universal English and so on, have distracted attention from the central issue.

(3) Some elements, notably the Germans,[1] and laggards and "manufacturers" have been antagonized needlessly.
(4) There has been lack of personal and direct appeal in many methods used. Ambiguousness and anonymity have often been faults of the material issued. The material in many cases has not been adapted to the audience addressed.
(5) Failure to cooperate with other organizations has lost much valuable support.
(6) There has been no adequate organization and no first class active supporters in the East.
(7) There has been no competent agent at the center of legislation.[2]
(8) Material has been needlessly long, often rather commonplace in appearance [26]."

Some of these acknowledged errors of omission and comission were rectified later in the campaign, but to no avail.

Following the publication of what Aubrey Drury liked to call his "big book" in 1922, the amount of literature issued by the World Trade Club dropped off drastically. The most likely reason for this curtailment is that the group's literature had provoked a sharp reaction from metric opponents, including an investigation of Albert Herbert and a number of "exposé" articles concerning his behind-the-scenes role in the World Trade Club. Considering Mr. Herbert's insistent demands that he remain anonymous, this state of affairs likely led him to withdraw the financial support needed to sustain a publications program. Although the organization did offer memberships to anyone willing to contribute, Mr. Herbert had always been the prime source of support and the other revenue was not sufficient to permit a great many activities to be undertaken. The organization ceased to exist altogether after the failure of the 1926 drive. Long before that, however, the establishment of the two pro-metric organizations had again aroused strong opposition.

3. THE AMERICAN INSTITUTE OF WEIGHTS AND MEASURES

Of all the special groups connected with the history of the metric system in the United States the anti-metric American Institute of Weights and Measures was by far the most organized, the most down-to-earth, and therefore, the most effective. It, too, ceased to be an active agent after the depression hit, but by that time it had done its job so well that there was really no further need for it.

Its creation was brought about through the efforts of those inveterate anti-metric polemicists Federick A. Halsey and Samuel S. Dale. Following the collapse of the pro-metric campaign in 1906-07, they had gone their separate ways—Halsey to edit *American Machinist* and Dale to edit *Textiles* and watch over tariff legislation. When they heard the first faint rumblings of a

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[1] The reason for this comment will be made clear in a subsequent section of this chapter.

[2] Since Crocker had been employed by the World Trade Club for several months at this time, Newton Drury must have held his efforts in low esteem.

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new drive to adopt the system, however, their paths quickly converged once more. It was Mr. Dale who, in early 1916, first suggested the efficacy of forming a permanent organization to watch over Washington activities having to do with weights and measures [27]. The actual work leading up to its establishment, however, he left to Mr. Halsey because of Halsey's availability (he had retired in 1911) and his more extensive connections with the manufacturing community.

Without the interest and financial backing of a few outstanding manufacturers there would never have been an American Institute. But men such as Henry R. Towne, a founder of Yale and Towne; Henry D. Sharpe, the treasurer of Brown and Sharpe; Edwin M. Herr, the president of Westinghouse; D. H. Kelley of the Toledo Scale Company; and Walter McFarland, formerly of Westinghouse and now with Babcock and Wilcox Company had long since committed themselves to opposing metric adoption. All that remained was to get them organized and to secure the support of their firms. By late June 1916, this had been done. As related by Mr. Halsey:

> "After a particularly flagrant, indirect and underhand movement by the pro-metric party last spring, our people awoke. Several meetings were held . . . under the leadership of Mr. Sharpe of the Brown & Sharpe Manufacturing Company, which resulted in a determination to organize a defense system. This has now reached the point where a constitution has been adopted . . . The committee in charge is now completing the council . . . It is understood that Mr. Sharpe will be president while others not less prominent have accepted membership in the council of which the list is now nearly completed. It is also understood that my coworker of a dozen years ago—Mr. S. S. Dale—and myself, will conduct the activities of the Institute as Associate Commissioner and Commissioner respectively [28]."

When all the results had been tallied, however, Mr. Sharpe had declined to head the new organization and Samuel Dale could not spare the time from his other duties to take a position, as "assistant commissioner," a title which he disliked anyway. Instead, a personal friend of Mr. Halsey, Walter Renton Ingalls, was chosen to serve as president. There was a certain opposition to his selection from among the backers of the Institute because Mr. Ingalls was not a manufacturer but a mining engineer. As it turned out, the position of president was to be only a figurehead job anyway so that Mr. Ingalls' selection proved to be satisfactory. Mr. Sharpe and Mr. Kelley were elected co-vice-presidents, Mr. McFarland became the Institute's treasurer, and Mr. Halsey was made the organization's first commissioner and secretary. A growing feud between Halsey and Dale prevented Mr. Dale's becoming officially connected with the Institute until Mr. Kelley stepped in as a peacemaker and secured his services as a "technical advisor" in October 1917. Samuel Dale continued to serve the organization in this capacity until late 1927, at which time he formally severed all connections with the Institute because of certain developments which he thought represented personal affronts.

In adopting a constitution, which was first done on June 28, 1916, the Institute set four goals for itself. Three of these were little more than meaningless "boiler plate"—maintaining and improving the English system of weights and measures, educating the people to the importance of English weights and measures, and improving old standards as well as developing new ones "for the good of our commerce and industry and the well-being of our country." The final goal, however, was actively pursued, and was, in truth, the real *raison d'etre* of the Institute. It called for:

> "The promotion of wise legislation for the conservation of our basic English units of weight and measure, and opposition to hasty and ill-considered legislation involving changes from our fundamental standards [29]."

Fortunately for those who were pushing for the creation of this group, there was plenty of legislation pending at this time that could be interpreted as being contrary to the interests of manufacturers.

For his first job as commissioner, Mr. Halsey set about canvassing the country for members, trying every method he could think of: publicity in technical and trade papers, mass mailings, and personal solicitation at conventions, and places of business. After a full year, he had secured membership pledges worth only $6,300 from 4 associations, 117 corporations and 43 individuals [30]. Quite possibly the main reason why Mr. Halsey was not more successful in his efforts to secure financing was that membership in the Institute was comparatively expensive. Individual memberships were $5; association dues were $100 for those that were national in scope and $25 for all others; and corporation dues were set on a sliding scale—$25 for firms with less than 500 employees, $50 for companies employing between 500 and 1,000 people, and $25 more for each additional thousand employees up to a maximum of $500 per year [31]. Mr. Halsey became disgruntled with the canvassing work in short order and requested the Institute's Council (the equivalent of a board of directors) to hire a professional solicitor. After this was done, the fortunes of the Institute were much improved. By October 1917, the number of members had risen to 209. By 1923-24, 650 members were contributing nearly $35,000 a year to the Institute's coffers. Although support fell off to only 500 members and $15,000 a year in 1926-27, this was still a substantial income and the Institute was relatively free of the economic problems which plagued the other interest groups of the era.

What the Institute did with its funds varied considerably from year-to-year, depending upon the existing status of pro-metric agitation. Even more than that, however, the Institute's activities were in large measure a function of who was running the organization's headquarters in New York. From the beginning until March 1920, Mr. Halsey was in charge as commissioner-secretary at an annual salary of $5,000. When he "retired" from active service at that time (still retaining the title of commissioner but without ever having collected his salary) he was replaced by Luther D. Burlingame. In September 1920, Mr. Charles C. Stutz, also a mechanical engineer, succeeded to the job. When Mr. Stutz died in January 1927, Mr. William E. Bullock assumed the secretary's job and held it until the Institute passed out of existence. Of the four secretaries, Mr. Stutz made the most substantial contribution to the success of the organization and the Institute was at its most visible best during his 7-year tenure.

Under Halsey, the Institute's activities were sporadic. Quarterly reports of activities were sent to all members (bearing the notations "strictly confidential" or "not for anyone else"), and a dozen pamphlets and publications were prepared for wide distribution. Among the pamphlets issued were ones entitled *The Six Metric Myths* and *Endorsements That Count.* Halsey also authored another paper for the American Society of Mechanical Engineers in 1918 on the subject of Latin-American weights and measures that was based on the results of a questionnaire. His principal concern, however, was obtaining general publicity for the anti-metric cause. A subscription to a newspaper clipping service was purchased by the Institute. When the pro-metric articles began rolling in, Mr. Halsey nearly went frantic trying to refute each and every one personally and in print. At one point in 1916 the situation was so bad that he confided to Mr. Sharpe:

"I am getting bluer than blue ruin . . . . One adverse influence after another piles up, and the situation is nothing less than desperate . . . . Mr. Dale and I must have support, and unless we can get it, I am prepared to throw up my hands [32]."

In fairness to Mr. Halsey, it should be noted that the Institute had not become a financial and organizational success overnight. He was struggling with a new organization and an uncertain situation. But Halsey did little to improve his own lot. He allowed his pessimism to surface on frequent occasions, often becoming openly despondent. He complained constantly, was argumentative about the most trifling matters, and managed to antagonize most of the people on whom the Institute was utterly dependent. In particular, he quarreled with Samuel Dale. Consider, for example, the following extracts from an exchange of correspondence concerning the nature and extent of Mr. Dale's participation in the Institute's activities:

June 26, 1917, Halsey to Dale—

"At our interview last week, I did not touch upon your broken promises for fear that the subject would make a bad situation worse. It can, however, be deferred no longer and below you will find extracts from your letters written prior to the adoption of the Constitution and showing not only your approval of all I had done, but specific promises made . . . .

In the face [of these words] . . . . you now condemn all that has been done, and refuse to cooperate . . . . You know perfectly well that I would not have been a party to the organization of this Institute but for your assurance of cooperation . . . .

[Y]ou cannot fail to recognize that I am aggrieved and that the *amende honorable* is due from you. With that, I shall be glad—more than glad—to forget and forgive, and following it, I shall be glad to take up your charges against me, which you have already made clear [33]."

June 27, 1917, Dale reply to Halsey—

> "You certainly are in a state of mind. It is difficult for me to take you seriously, but as you presist in your attitude, I suppose I must do so.
>
> I make way for no one in my readiness to acknowledge the great service you have rendered in defending our established standards, and in promoting the organization of an association to carry on that work. In my judgement there would have been no association at all if it had not been for you.
>
> So much for yourself. Now as for me. There is not a word I have written or spoken that you quote or fail to quote that is in any way inconsistent with my position now. I gave you my idea of what the organization should be at the start, and stated the only conditions under which it would be possible for me to take an active part in it.
>
> I have deliberately and persistently kept my views in the background, in order that the movement for an association might not be wrecked by a conflict of opinions. My expressions of dissent have been made to you orally or in writing. That dissent has been stated as emphatically and tactfully as possible . . . .
>
> Having avoided any interference with your development work, having confined my suggestions and advice to you, leaving you free to deal with your people as you pleased, with your admission that you disregarded the conditions under which I could cooperate, there is absolutely no one but yourself to blame for the results.
>
> If you are in a false position, you have been placed there by yourself [34]."

This particular disagreement between Halsey and Dale was settled by the Institute's vice-president, D. H. Kelley, acting as an intermediary. There were to be several other violent disputes between Halsey and Dale, though, on a variety of subjects. Most of these, if not all of them, were started by some action on Halsey's part which offended Mr. Dale. Such incidents included Halsey's publication of several articles that were written by Dale without attributing authorship to him and a disagreement over the wisdom of spending funds to publish a second edition of the *Metric Fallacy*. A revised edition was issued eventually, but without Mr. Dale's part, "The Metric Failure in the Textile Industry [35]."

Such a tempestuous relationship could not continue forever, of course, as it would have jeopardized the success of the entire Institute. Halsey was not on the best of terms with Mr. Towne and Mr. Sharpe to begin with, and there is every indication that his quarrel with Samuel Dale hastened his retirement in 1920. For this, he apparently blamed Dale, as evidenced by another stinging letter written in November, 1921:

"That quarrel of ours had consequences of which you know nothing. I have never for a moment intended to permit it to remain as it is, for self respect forbids, and I am astonished at my own moderation in allowing it to lie so long. I can well understand that you should wish me to 'stop threshing over this old straw' but that, interpreted, means that I shall forget an injury and forgive a deserter, which is impossible . . . .

. . . I have read anew the miserable correspondence and my blood boils anew, for this case is mine as clearly as the weights and measures case is ours.

The idea of a defense organization was yours. I took it up because you urged it and because you wholeheartedly promised to stand by me to the end . . . You were a party to the formation of the Institute. You approved the draft constitution . . . with suggestions for additions that were incorporated. You repeatedly approved everything I had done . . . until the organization was complete, except for finding a president.

Later, when for 8 months the organization was out of my hands and control, I having not even a membership on any committee, you began to express doubts of the wisdom of what had been done . . . Comparing your plan of work as then outlined with the one then and now in force, no one can discover what the hullaballoo was about.

As far as your belief that the sum I had in mind could not be raised . . . it has been exceeded; your repeated predictions of failure of the institute have come to naught, and experience has shown that the amount you named as sufficient was ridiculous—three examples of your poor judgement, but there are others.

. . . I continued to hope against hope that I could raise enough [money] to justify asking you to come in under pay, and finally I told the Executive Committee that your cooperation was imperative and that if they could thus secure it, your salary should always have presidence [sic] over mine. Theretofore, I had not been paid a cent on account of salary and thereafter your salary was paid monthly from funds that I had raised while I went without. And today, if my unpaid and rescinded salary is anything, I am the largest single, individual or corporate, contributor to the Institute.

During the interval between your engagement and my leaving the office, the amount paid to you would have come to me had it not gone to you, which being interpreted, means that my devotion to this cause was such that, during the interval, in order to secure your cooperation, I paid your salary.

The trouble with you, Dale, is that you have no sense of personal loyalty and no capacity for team play. I must play the game your way or be deserted in the hour of greatest need.

Should you quote from this letter, see to it that you quote correctly. I am tired of your attempts to prove your case by misquotations [36]."

But by this time Samuel Dale had had enough. In a mild reply to Halsey, he stated that he had imperative business matters to attend to and, as a consequence, "I must . . . rest under the charges and suffer the condemnation which you heap upon me [37] . . . ." After that final exchange, the relationship between these staunch anti-metric collaborators grew increasingly cooler, although they kept in fairly close touch with each other.

The operations of the American Institute of Weights and Measures also grew progressively smoother and more effective after Mr. Halsey's departure. Under the energetic and able command of C. C. Stutz its full potential was attained. A quarterly *Bulletin*,[3] was issued that contained news of interest to metric opponents and regular reports of the Institute's activities. Professional and trade associations were lined up behind the Institute's banner, and their publications served as a handy and reliable outlet for the group's anti-metric circulars and "news releases." Meetings of interest to the Institute were routinely attended by one or more of the several full-time staff members that were employed and, of course, the Institute was always represented at Congressional hearings. For each piece of legislation proposed, a full "brief in opposition" was prepared by the Institute's counsel and, when hearings were held, opposition witnesses were conveniently arranged by the Institute. This mode of operation was carried on by Mr. William E. Bullock beginning in 1927. But, by that time, the crisis had passed and there was very little for Mr. Bullock to do except watch and wait until it became certain that this campaign had come to an end.

Vigilance was the key to the organization's success. Very little occurred in the jurisdictions of the Committee on Coinage, Weights and Measures or of the National Bureau of Standards that the Institute did not scrutinize to determine whether or not their interests were involved. When some proposal or action aroused the Institute's suspicions, that proposal or action was denounced with conviction by every means at the disposal of the organization. As a general rule, the appearance of strong opposition from the Institute, from the manufacturers, from powerful associations, and from the publications which routinely backed the Institute's position, was enough to forestall serious consideration of proposed legislation. In other ways, too, the Institute was operating from a position of strength. To all appearances they based their cases on common sense and on facts or informed judgments rather than on irrational assumptions or emotional appeals. In addition, they had no constructive program of their own which required legislative action or approval. Instead, all they had to do was prevent the metric advocates from successfully executing their program. Not only was this an inherently easier task, but it was made even simpler by some of the sympathizers' own serious mistakes.

Whether or not pro-metric legislation would have been enacted without the Institute's active opposition is useless speculation. On several previous occasions bills had gone largely unopposed and had never succeeded, but the 1920's were different times and the circumstances had changed. Whatever might have happened did not, and the Institute's contribution to the failure of metric proposals during this period cannot be underrated. When the dust of the metric crusade had settled early in the 1930's, the American Institute

[3] The name of which was changed to *Weight and Measure* beginning in July 1927.

of Weights and Measures had accomplished what it had set out to do in 1916. As a consequence, the metric issue was again laid to rest for over 25 years.

4. OTHER PARTICIPANTS

Organized metric interest groups were not the only participants in the controversy during the years 1914-33 even though they did provoke most of the action.

In the Senate of the United States the proposal to adopt the metric system found a new champion in the person of Edwin Freemont Ladd. Born in Somerset County, Maine, in 1859, Mr. Ladd was a chemist by profession and did not enter politics until late in life [38]. After serving for over 25 years as the chief chemist of the North Dakota Agricultural Experiment Station, he was elected to the Senate from that State in 1920 as a "Nonpartisan Republican." Although he served in the Senate for only 5 years, Mr. Ladd was a perennial sponsor of metric legislation during that time and it was primarily through his good offices that formal hearings were arranged before the Senate Committee on Manufacturers in late 1921 and early 1922.

In the House of Representatives there were a greater number of supporters, including Congressmen Albert H. Vestal of Indiana and Randolph Perkins of New Jersey, who served as Chairmen of the Committee on Coinage, Weights and Measures for most of the years during this campaign. The principal champions of metric legislation, however, were Frederick H. Gillett from Massachusetts, who was to become Speaker of the House in 1921, and Fred A. Britten of Illinois. All of these Representatives were members of the Republican Party, which held a majority of both Houses of Congress between 1919 and 1931.

The metric controversy cannot be viewed as a partisan affair, however, since Mr. Dale and Mr. Halsey were also lifelong Republicans. It is a fact, however, that the cycles of intense metric agitation between 1896 and 1933 coincided with the years in which the Republican Party was in power. The most likely explanation for this correlation is that both occurrences—metric agitation and Republican domination—resulted from changing trends in the prevailing economic, social and political conditions. As a Nation we were clearly in an isolationist mood and, under those conditions, not inclined to look favorably upon any reform whose main justification was based upon international prestige and goodwill. The proposed adoption of the metric system was just such a reform.

Another party to the controversy over the metric system during the years 1914-33 was the National Bureau of Standards. First under director Stratton, until 1923, and then under Dr. George K. Burgess, the Bureau officially espoused the position that the metric system was to be considered preferable for scientific and weights and measures work, but that, as a Government agency, NBS could not recommend legislation compelling adoption of the system for general use [39]. Not only was this position viewed with great skepticism by the opponents of metric adoption, but the activities of some individual staff members did little to dispel the appearance that the Bureau was actively promoting the proposed reform. For this reason, the American Institute of Weights and Measures, and Samuel Dale in particular, kept a close watch on the publications and activities of the Bureau and constantly sought to have Secretaries of Commerce clamp the lid on NBS's "agitation" for the metric system.

One of the activities of the National Bureau of Standards of which the opponents were especially suspicious was its sponsorship of the National Conference on Weights and Measures. Initiated in a modest way in 1905, the Conference had become an annual affair to which most States sent several delegates by 1920. Its purpose was to bring together State Officials working in the area of weights and measures regulation to discuss new methods for testing commercial weighing and measuring devices, for insuring honest weights and measures usage and inspection and, above all, for reducing the almost infinite variety of laws affecting weights and measures [40]. In the 1910–30 period, the Conference was promoting legislation, both State and Federal, to correct some of the most serious deficiencies in existing regulatory practices. Two types of proposed legislation along these lines particularly infuriated the opponents of the metric system. One group of bills provided for the adoption of standard sizes for berry baskets for use in commercial transactions. Another class of proposed legislation would have given the National Bureau of Standards the authority to inspect and approve commercial weighing and measuring devices (by generic type, not individually) before they could be used in business transactions involving interstate commerce. What provoked opposition to these bills from Mr. Dale and the American Institute was that portions of them were worded in the following fashion:

> "The standard of weights and measures throughout the United States shall be the weights and measures supplied by the United States Government under joint resolutions of Congress, approved June fourteenth, eighteen hundred and thirty-six, and July twenty-seventh, eighteen hundred and sixty-six, and such new weights and measures . . . . as have been or shall be established by the several States, Territories, and the District of Columbia, and approved by the Bureau of Standards [41]."

Such provisions were objectionable in that they contained "metric jokers"—the 1866 joint resolution cited had provided for the construction and distribution of metric standards. Even through the 1836 resolution, also cited, had dealt with customary standards, the metric system's opponents believed that the Bureau of Standards would implement the law in such a way that the metric provisions would always apply. Nor could the States be relied upon to counteract the Bureau's influence in this direction because, it was felt, the National Conference on Weights and Measures was little more than a State lobby group for NBS. To the metric opponents, then, such bills as these constituted metric legislation of the most insidious type and had to be stopped.

Strange though it may seem, two other Government efforts that were intimately connected to standards and systems of weights and measures were successfully executed during this time period without being dragged into the metric controversy. These were: (1) a significant revision of American screw thread standards; and (2) a "simplified practice" program aimed at conserving raw materials and eliminating waste by such means as reducing the number and variety of sizes to which American products were manufactured.

In July 1918, a National Screw Thread Commission was established by Act of Congress "to ascertain and establish standards for screw threads [42]." Its chairman was the director of the Bureau of Standards. Since screw thread standards had always been high on the list of objectionable changes that would have to be made if the U.S. adopted the metric system, this Commission should have made a natural target for metric opponents, especially considering its leadership. This did not occur, however, and the Commission finished its work undisturbed.

The "simplified practice" movement also avoided entanglements with metric adoption battles, probably because compliance with any industrial standard that might be set was strictly voluntary [43]. In addition, no serious drive was launched to have the new standards and specifications formulated in terms of the metric system. This may have been because the champion of simplified practice was Secretary of Commerce Herbert Hoover. Mr. Hoover was well aware of the lack of agreement that existed concerning the feasibility and desirability of metric adoption and he steadfastly refused to take a position on this issue. The simplified practice effort was one of Mr. Hoover's favorite programs, and he certainly would not have wanted it jeopardized by becoming the focal point of a battle over weights and measures.

And so, with interest in metric adoption gradually increasing, with legislation promoting it regularly being introduced in Congress, and with the formation of organized interest groups, the great metric crusade was ready to begin.

B. SQUARING OFF (1914-1918)

This campaign may very well have been started by the Nation's wholesale grocers. In an address to the National Conference on Weights and Measures in May 1914, the ex-president of the National Wholesale Grocers' Association of the United States, Mr. Fred R. Drake, announced that his was the "first great trade association to come forward and advocate the needed reform." Furthermore, he said that the grocers' association, not wishing to see the failure of 1906-07 repeated, was already in the process of conducting an educational campaign aimed not only at wholesale and retail grocers, but also at the ultimate consumer. Its object, of course, would be to familiarize citizens with the metric system so that, eventually, legislators might be appropriately enlightened. Mr. Drake urged a similar course of action upon the National Conference on Weights and Measures. "If all the friends of the Metric System," he said, "would join hands in a publicity campaign setting forth the merits of the reform, it could be done; and you, gentlemen, coming from most of the States of the Union, are in a position to do more to bring this about than any other class of citizens who occupy positions under the Federal Government or the States [44]." This campaign was to come to pass, and Mr. Drake would play a significant part in it as an officer of the Metric Association even though the Conference declined to act on his suggestion.

In that year, and in several preceeding years, legislation had been proposed in the House "to regulate and control the manufacture, sale and use of weights and measures," but these had little to do with the larger question of adopting the metric system. In January 1915, however, the first metric bill since 1906 was introduced.[4] It was sponsored by a Representative Dillon of North Dakota and provided for the establishment of the metric system "as the standard for weights and measures, and for other purposes." A similar bill was filed later that same year and other proposals, with only minor variations, were introduced in 1917 and 1918.[5] None of these ever received consideration by the House Committee on Coinage, Weights and Measures. During these years most of the legislation that came before the Committee were bills to standardize berry basket sizes and proposals to authorize the Bureau of Standards to pass on weighing and measuring devices, some of which contained "metric jokers."

For having assisted the National Conference on Weights and Measures in framing such legislation, and for his role in the metric campaigns of a decade earlier, Director Stratton was severely rebuked by Samuel S. Dale. In a 17-page letter detailing Dr. Stratton's "errors" on a case-by-case basis, Mr. Dale questioned the propriety, the legality, and the constitutionality of both his official policies and personal activities. Dale summed up his position in the following statement:

> "My objection is to your allowing [your] opinions to influence improperly the official policy of the Bureau of Standards. You say 'the verdict of the scientific world as to the merits of the metric system cannot be ignored.' I would remind you that the Bureau of Standards was established by a law that is enacted by Congress and not by 'the verdict' of what you call 'the scientific world.' A certain class of men that assume the sole right to be called 'scientists' may find the metric system convenient because they use it, but the Bureau of Standards is not authorized to carry out the desires of that class in disregard of the rights and interests of the people of the United States. You have shaped the pro-metric policy of the Bureau of Standards for the benefit of the scientific class, your own class, in disregard of the interests of the American people, and in defiance of law and the constitution, which expressly withholds the power to fix standards of weights and measures from your Bureau and gives it to Congress . . . .

[4] H.R. 20526 (Jan. 4, 1915).

[5] H.R. 151 (Dec. 6, 1915); H.R. 3662 (Apr. 23, 1917); H.J. Res. 132 (July 30, 1917); and H.R. 10475 (Mar. 5, 1918).

It is by no means unusual to find [an] assumption of superior knowledge and wisdom by those who belong to what you call 'the scientific world.' . . . .You may be convinced that it is on your shoulders, and in map construction. Artillery and machine gun material intended for service abroad is being graduated accordingly. Instruction in the metric system will be given to all concerned [54]."

Whatever else Dr. Stratton may have been convinced of, he was certain that he had a job to do and that it involved bringing the U.S. into line with other nations in its system of weights and measures. He was not to be deterred by the likes of Samuel Dale, for he clearly saw nothing improper about stating what he considered to be a fact—that the metric system was a superior system of weights and measures. Less than a year after the above letter was written, Dr. Stratton again demonstrated his sincere belief in the propriety of his position by authoring a report entitled *The Metric System in Export Trade* [46]. This report had been occasioned by a request from Treasury Secretary W. G. McAdoo to Commerce Secretary William C. Redfield asking for information "on the attitude of our great manufacturers in the matter of the metric system." This information was to be used by the American delegates at a forthcoming session of an "International High Commission." Considering the opposition to the metric system that had been openly exhibited by certain manufacturers, it is not difficult to imagine the angry consternation that Mr. Dale must have registered as he perused Dr. Stratton's somewhat dogmatic report.

In answer to a specific question raised by Secretary McAdoo concerning the percentage of manufacturers that had already adopted the metric system in preparing goods for export, Dr. Stratton said that exact figures couldn't be given but that:

"Most firms [seeking export business] use the metric system to meet the need for intelligible catalogues and price lists, to meet in many cases also the insistent demand for products in metric sizes, and finally to satisfy the customs requirements of the country concerned. The enterprising exporter meets these requirements as fully as possible. The factories are conservative and require education, since they are not brought directly in such close touch with foreign needs . . . .

With the growing use of the metric system at home and abroad, it is clear that not only is the policy of extending its use in manufacture warranted, but it is essential [47]."

Dr. Stratton further acknowledged that objections to metric adoption had been raised: the use of two systems of measurement, the cost of adoption, the psychological effects of the change on the workmen, the notion that standard sizes geared to customary units would have to be abandoned, and the belief that our strong ties with England dictated the retention of English measures. Without elaborating further on the basis for these objections or on the source of them, Dr. Stratton presented a vigorous refutation of each one, all leading to the conclusion that "the extent to which advance should be made toward the complete adoption of the metric system is the only question seriously discussed today, since its partial adoption is an accomplished fact [48]." He did admit that the metric system appeared to be less adaptable to the textile and machinery industries than to other product lines, but Dr. Stratton asserted that such difficulties could be overcome and with beneficial results:

"The effect [of metric adoption] will be, as in all considerable innovations, to awaken a measure of opposition, not in sales departments but among the older workers among whom set practice has removed the fine edge of enterprise . . . .

The effect will next be to awaken the ingenuity of the younger trained technical men in meeting the demands of the world market. Attention to the world units of measurement will in turn awaken their desire to assimilate the best in foreign practice in order to improve products and methods of manufacture [49]."

Director Stratton's report on the metric system in export trade was like an official signal for the battle to begin. Later that same year both the Metric Association and the American Institute of Weights and Measures were formed. The substance of his report had also set the general tone for the major argument used by the pro-metric forces during this era. This was that the size of American foreign trade virtually demanded that we keep pace with the rest of the world by adopting the metric system. The United States Section of the Interamerican High Commission, for whom the report had been prepared, concurred in this opinion. At its session on October 7, 1918, it passed a resolution to the effect that "the adoption of [the metric] system would be productive of great advantage in the commercial relations of the United States with the other American Republics [50]."

The big flaws in the foreign trade argument were still the facts that American export business was flourishing without the metric system and that Great Britain had not yet adopted it either. Because there was a war going on in Europe, the American export picture had never been brighter, especially with respect to sales of machinery. Between 1915 and 1916 alone the value of machinery exported rose from $120 million to $278 million, and this amount increased nearly every year until 1921, reaching a peak of $588 million in 1920 [51]. In cotton manufactures, the rise was less drastic but still significant. Exports of these commodities, which stood at $70 million in 1915, increased over the next 5 years to $398 million [52]. Of the total value of exports during the war years, over 60 percent routinely went to Europe, and half of this went to Great Britain [53]. In fact, our biggest trading partners for some years to come would be the United Kingdom and Canada, both nonmetric nations. From these figures, it is easy to see why American manufacturers felt little pressure to adopt the metric system. Even when exports leveled off after the war, the U.S. was exporting far more than it had in 1915 and our manufacturers' principal competitor for South American markets, Germany, had been eliminated from the trade race.

Even while the war was raging, however, the campaign for metric adoption continued. Logic and economic necessity would seem to dictate that no change should be made in our measurement system while American industry was geared to wartime production. And yet, during the First World War there was a compelling reason to push even harder for such a change. That was the fact that some of our major allies, France in particular, were dependent upon armament and military equipment that was produced using the metric system. The lack of metrological uniformity among the allies was, in fact, a serious problem and because of it both Great Britain and the United States were forced to make some changes to accomodate the need for metric-based supplies.

On January 2, 1918, General Order No. 1 was issued by the War Department in Washington. It stated that:

> "The metric system has been adopted for use in France for all firing data for artillery and machine guns, in the preparation of operation orders, and in map construction. Artillery and machine gun material intended for service abroad is being graduated accordingly. Instruction in the metric system will be given to all concerned [54]."

As a consequence, the Bureau of Standards set about reissuing a number of its earlier publications that explained and illustrated the metric system. The *piece de resistance*, however, was a booklet entitled *Metric Manual for Soldiers.* Although the basic purpose of this booklet was to enable the American soldier to deal effectively with a system of weights and measures to which he was unaccustomed, someone at the Bureau could not resist the temptation to include a little promotional material along with the necessary tables and text. After describing the metric system as "an international decimal system of weights and measures adopted as the legal standard by France and 33 other nations and in worldwide use," the booklet went on to say that:

> "The rapid progress of the metric system in the United States is caused by the growing recognition of its merits and the need for an international system especially in science and commerce. Many industries are using it without special legislation [56]."

To the dismay of metric supporters, and to the delight of the opposition, any momentum in the direction of metric adoption that had been built up during the war years rapidly disintegrated after the armistice was signed on November 11, 1918. On May 3, 1920, General Order No. 26 was issued by the War Department rescinding the metric provisions of 1918 and ordering a return to the use of "customary British units [57]." But world conditions had been drastically altered as a result of the war, and that situation provided the impetus for an even more intense metric drive.

In Great Britain, too, the war had a pronounced impact on agitation for the metric system. In the words of historian Edward F. Cox:

> "[T]he advent of World War I apparently was one of the leading causes for the occurrence of the third pro-metric campaign in Great

> Britain . . . . The cooperation necessary with metric system allies in the war resulted in considerable use of the system by the British, and also caused some confusion. It was undoubtedly due to these factors that once more was raised the question of British adoption of the system in use by so many of the Allies [58]."

The post-war British campaign was marked by a revival of the pro-metric Decimal Association, an organization which formally banded together with the American Metric Association and the World Trade Club in 1920 to form what was known as the World Metric Standardization Council. This was in all respects, a very loose alliance, however, based mainly on a common goal and a common fondness for the use of the weapon known as "propaganda." Unlike the great metric crusade in the United States, the third metric campaign in Great Britain was over with swiftly. According to Dr. Cox, the Decimal Association quickly ran out of funds and by late 1920, their drive had all but ended [59]. Because of this, American metric advocates could not, and did not, place so much emphasis during these years on the argument that British adoption was imminent and the U.S. would have to follow sooner or later.

But there were plenty of other arguments to use, including the "increased foreign trade" contention, the inevitability of worldwide use of the metric system, and above all, the claim that opposition to metric adoption was based on fears that were groundless. A very accurate characterization of the campaign to come was provided by Justin W. McEachren, editor of *The Valve World*, in an address to the American Metric Association in 1917:

"[W]e have in the United States two opposing forces, each with an organized head, and each striving (let us say it frankly) honestly for what it believes to be the best thing for American business . . . .

The object of each side is the same—the welfare of the United States. The methods suggested for the attainment of the object are diametrically opposed.

On our side of the line . . . we naturally ask: Why is there opposition to our advancement? Why do we have to fight for every foot of ground we gain? Why is a part of American industry and commerce in favor of the widest adoption of the Metric System, and another part of American industry and commerce stoutly opposed to any change in our present common units of weights and measures?

Without going into all the details of an analysis of the opposition, I say, deliberately, that the chief reason for this opposition is fear; and fear generated very largely within the ranks of the opposition itself.

Opponents of the Metric System have persuaded themselves that such use of the system as this Association advocates would be *enormously* costly; *tremendously* disturbing; *vastly* confusing; and *altogether* inimical to American industry and trade.

They have used up all the superlatives in telling themselves about the calamities they fancy we are trying to bring upon our country's business, and by this process of auto-suggestion they have worked themselves into a state of fearfulness, behind which they are now intrenched for an organized defense of their sacred and archaic standards [60].

I am persuaded that ninety-nine per cent of the opposition now existing against the further use of the International Metric System in this country is due to indefinite, over-enthusiastic, ill-considered, and unconvincing language fired without preliminary observations from our own side of the line [61]."

Accordingly, Mr. McEachren suggested a constructive, low-key program aimed at collecting authoritative evidence in support of pro-metric contentions and at bolstering the integrity of the pro-metric cause in the eyes of legislators and production managers. But his admonitions went largely unheeded. Seldom was the real problem seen by other participants as clearly as Mr. McEachren had seen it, nor were others as charitable in their attitude toward "the other side" as he had been.

As World War I was drawing to a close and American industry was preparing for a "return to normalcy," the campaign, which had been largely ignored, began to attract more attention. This was due to a renewed involvement in the question by some prominent individuals and institutions. To begin with, in June 1918, a committee of the American Society of Mechanical Engineers issued a predictably anti-metric report dealing with the foreign trade issue [62]. What made the anti-metric aspects of the report predictable was that the committee was chaired by Luther D. Burlingame, an officer of Brown and Sharpe and a future secretary of the American Institute of Weights and Measures, and included as members Mr. E. M. Herr and Frederick Halsey. In fact, one of the main items considered by the committee in reaching its conclusion was a paper prepared by Mr. Halsey for the American Institute of Weights and Measures [63], and later reprinted in modified form by the Society [64]. The main purpose of the committee's investigation was to report on the status of metric usage among American business interests engaged in export trade. To this end, over 6,000 exporting manufacturers had been asked to respond to a questionnaire, and 1,445 of them had done so. The manufacturers had been asked to give graded reactions to three statements [65]:

(1) "In our factory work, and in order to adapt our goods to the needs of buyers in metric countries, we have found it desirable to abandon English measures and use, instead, dimensions of our products to the following extent:"

(2) "We have found it advisable to pack our goods in containers of metric dimensions or containing metric weights to the following extent:"

(3) "In our literature for and correspondence with metric countries, we

have found it advisable to give information regarding weights, output, capacities, overall dimensions, etc., in metric terms as follows:"

These three questions had obviously been triggered by Dr. Stratton's assertions in his 1916 report to the High Commission, and the metric opponents must have been delighted with the answers. When the replies had been tallied, the results were overwhelmingly anti-metric [66]:

Response	Question No. 1 (percent)	Question No. 2 (percent)	Question No. 3 (percent)
Not at all	82.3	51.6	57.8
Slightly	11.2	1.7	19.3
Considerably	2.0	1.1	7.9
Extensively	1.1	0.9	5.4
Exclusively	0.3	Negligible	2.6
No reply	3.1	6.8	7.0
Other	0	37.9	0
Total	100.0	100.0	100.0

Halsey's report on "The Weights and Measures of Latin America," issued in December 1918, was just as negative about the status of the metric system on the receiving end of foreign trade. Briefly stated, his survey had disclosed that attempts to introduce the metric system into Latin America had been failures. Basing his opinion on the returns from a questionnaire, 500 copies of which had been sent to "outside agencies" in Latin American countries, Halsey asserted that in only one country—Uruguay—had the metric system been adopted for domestic trade [67]. In 10 other countries, he had found that the metric system had made "very little impression" in spite of the fact that it had been officially adopted. This failure to gain acceptance was attributed by Halsey to the fact that governments had relied on laws to make the system compulsory, But, he said, such laws were ineffective "because established and harmless practice cannot, except in a technical sense, be made a crime [68]."

In direct contrast to these two anti-metric documents, the expressed opinion of Secretary of Commerce William C. Redfield was that metric adoption would be more important to American foreign trade in the postwar years than ever before. Addressing the Metric Association at its 1918 annual meeting, he stated:

"I have heard men say that America can sell and is selling quantities of goods abroad without the use of the metric system. Certainly she has. She can do that to a certain extent, but compared to what America could do if she would adapt herself to the needs of the people abroad, it is like selling cheap remnants [69]."

Secretary Redfield also opened up a line of argument at this time that would become very popular in the metric camp over the next few years. Noting that "Germany's industrial strength was due to the application of scientific knowledge," he also observed that Germany had started to become a large-scale industrial competitor "after '71 or '72." While the connection between these two statements was not made by way of an outright assertion, the implication was clear—1871 was the year in which Germany had adopted the metric system. The rapid industrial growth of Germany, therefore, must have been occasioned in no small measure by the fact that she had chosen to use the superior, scientific metric system. At least this was what some supporters of metric adoption chose to believe, and they felt that there was a great lesson to be learned by this experience. They declared that the U.S. ought to take advantage of it and they promptly set out to accomplish this end.

C. THE BATTLE FOR PUBLIC OPINION (1919-1922)

Until 1919 the methods employed in debating the metric issue were not significantly different from those used in previous campaigns. With the appearance of the World Trade Club in that year, the situation changed. The Club's new approach to metric campaigning was heralded by one of its first actions—the retention of W. Mortimer Crocker as its Washington representative. One of Mr. Crocker's main jobs was to keep the metric issue alive by encouraging the introduction of appropriate legislation. This he was able to do.

1. LEGISLATIVE PROPOSALS

In December 1920, two nearly-identical metric bills were introduced, one in each House of the Congress.[6] The Senate bill was filed by Senator Frelinghuysen of New Jersey with the notation that it was being introduced "by request." It was sent to a select Committee on Standards, Weights and Measures, which never took action on it. On the House side, a bill was introduced by Representative Britten of Illinois, and was referred to the Committee on Coinage, Weights and Measures. This bill bore the unmistakable stamp of the World Trade Club—a reference to the metric system as the "meter-liter-gram" system—although there was no indication that the proposal was being made "by request."

Both of these bills were long and complex, but they had the identical purpose of fixing the metric system "as the single standard for weights and measures" 10 years from the date of enactment. But the provisions of the bills did not apply to certain activities. Specifically excluded, no doubt in anticipation of stiff opposition, were: (1) contracts made before the effective date of the Act; (2) "*the construction or use in the arts, manufacture, or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed, or graduated in any desired system*"; and

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[6] S. 4675 (Dec. 16, 1920) and H.R. 15420 (Dec. 29, 1920)—66th Congress, 3d Session.

(3) merchandise intended for sale in a foreign country. This meant that manufacturers would be able to use any system they wanted in making their products, just so long as the goods were sold and transported according to their equivalents in the units of the metric system. Other provisions included in these bills would have required: (1) that after 4 years, all weights, measures and related devices manufactured and sold in the U.S. (except for industrial use) be metric; (2) that after 4 years "any goods, wares or merchandise in package form which are required by law to be marked in terms of weight or measure" bear metric designations; (3) that at the end of 10 years all postage, excises, duties, and customs would be charged or collected according to the metric system; and (4) that existing Government regulations and tariff schedules, regardless of how they were originally written, were to be construed in terms of the metric system after the effective date of the Act. The Secretary of Commerce was to be given the responsibility for implementing the act and for publicizing the transition dates.

These bills were as close to being compulsory in their impact as the metric supporters dared to come. Except for the provision that exempted manufacturing interests, which was a transparent attempt to take away the opposition's argument that their interests had not been considered or protected, virtually all sectors of American society would have been converted to the metric system under these bills over a 10-year period. The opponents of the metric system, of course, were not assuaged by the maneuver. The other provisions were so comprehensive, they felt, that manufacturers would have very little choice in the matter and would be forced to adopt the metric system along with the rest of the country. This, obviously, was just what the proponents of the system had in mind.

These bills established the general pattern for metric legislation for the next few years. In the 67th Congress, from 1921 until 1923, two similar bills were pending. Mr. Britten introduced *H.R. 10* (a significant number to metric advocates) on April 11, 1921, and Senator Ladd proposed *S. 2267* on July 18 of that same year. The Senate bill was referred to the Committee on Manufactures and hearings were scheduled to begin in October.

In the meantime, an entirely different class of legislation dealing with the same subject was also being considered by the U.S. Congress. On March 26, 1920, Representative Welling of Utah introduced a bill,[7] "to establish the standard and decimal divisions of the weights, measures, and coins of the United States." Mr. Welling had filed this proposal on behalf of Mr. Samuel Russell, the secretary to his Senate colleague from Utah, Mr. King, who had introduced an identical bill in the Senate on February 20, 1920.[8] Mr. Russell's idea was to establish the length unit of the customary system, the foot, as the basic unit from which the others would be derived (volume being defined in terms of cubic feet, weight being derived by cubic feet of water, etc.). In addition, all multiples and subunits of this system would be defined by utilizing decimal ratios, the foot being divided into 10 "decimal inches" of

[7] H.R. 12850; 66th Congress, 2d Session.

[8] S. 3943; 66th Congress, 2d Session.

1.2 customary inches, the measure of volume consisting of 10 "decimal cubes" (i.e. a cubic "decimal inch"), and so on. The coinage system would also have been revised under Russell's plan. Quarter- and half-dollar coins would have been eliminated from the system and replaced with 1- and 2-franc pieces worth 20 cents and 40 cents respectively. Gold coins were also to be minted in the following denominations: the pound ($5), the eagle ($10), and the double-eagle ($20).

Except for the coinage provisions, Mr. Russell's proposal was essentially a 20th-century revision of Thomas Jefferson's decimal-system plan of 1790. It did not receive the support of either the metric-system enthusiasts or the staunch defenders of the established customary system because neither system was provided for under the bill. Nevertheless, the proposal was considered by the House Committee on Coinage, Weights and Measures in 1920 and the Senate Committee on Manufactures in 1921, most likely in deference to Mr. Russell's official connection with the Senate [70]. Even though neither of the Committees ever submitted a report on this proposed systems of weights and measures, Mr. Russell kept on trying until 1922.[9]

By that late date, however, it should have been obvious that there were only two courses of action available to the U.S.: keeping the customary system for all practical purposes or officially supplanting it by adoption of the metric system.

2. THE PRO-METRIC CASE

The 1921 Senate hearings on Mr. Ladd's bill were preceeded by 2 years of flag-waving and ballyhoo designed to leave the impression that metric adoption was the panacea for America's metrological ailments.

The pamphlets and other literature generated by the World Trade Club/World Metric Standardization Council were outstanding examples of the extreme form of publicity frequently employed by a few metric advocates during this campaign. In a pamphlet entitled *Keep the World War Won*, for instance, America's temporary utilization of metric measurements for military purposes and Secretary Redfield's oblique references to the reasons for German industrial might were stretched to the point of incredulity:

"One of the great victories of the world war was the defeat of an outworn German jumble of weights and measures, and the adoption by America and Britannia for military purposes—that is for purposes of efficiency—of a simple and logical decimal system of weights and measures. Peace must have its victory as well as war. Now it is for us to apply the lesson learnt [sic] from the world war to the activities of peace—to education, trade and all the relations of life. We must adopt the metric units if we are

[9] Mr. Russell's proposal was also introduced as: S. 565 (April 12, 1921); H.R. 8163 (Aug. 10, 1921); and H.R. 11733 (May 22, 1922).

to make the best of our opportunities and keep the world war won . . .

World Trade Club knows of no way in which it can so well do its bit in avoiding another war as to aid in establishing the exclusive use of meter-liter-gram in U.S. America and Britannia—bringing about complete standardization of these nations with their 30 allies.

Our Weights and Measures Made In Germany—Forced Upon Us By Germans

Strange as it may seem the present coinage of the British Isles as well as the weights and measures of the British Isles and of America are German.

The British pounds, both sterling and avoirdupois, originated with the old German Hanseatic League, which for hundreds of years controlled the trade of England . . . [T]he dominance of the Germans in England continued until a competent business manager ousted the Hanse League from England—and it was a woman who did this patriotic work: Elizabeth.

The Germans forced these old standards on the British, who in turn landed them on America. America and Britannia were one until 1776.

Germany Herself Scrapt Them

What is most remarkable is that America and Britannia continue to use these old German tools after Germany herself has scrapt [sic.] and forgotten them, and adopted the simplest, decimal system of quantity expression ever known to human-kind—the application of the decimal to weights and measures, the invention of that truly great Briton, James Watt . . .

Germany adopted the metric system in 1871, and the secret of the much-vaunted efficiency of the German military forces was that by means of the metric units all elements in her educational, industrial, commercial and military structure were standardized, with all details fitting and working interchangeably together.

Confused Standards of the Allies

The Allies, on the contrary, had at first, no such standardization and interchangeable uniformity . . . Even British and American measures were not interchangeable, with the result that great and grave difficulties, long costly delays, interfered with their doordination and efficiency promptly to aid their allies.

The Kaiser Counted on this Confusion

We know that the German Kaiser counted upon this confusion for 2 years' delay in the war preparations of the allies. We know that he expected to crush France and gain world power before the allies, thus handicapped, were really ready to fight . . .

"Get the Thing Done"

. . . As we stand on the threshold of world peace, let us prepare to reap and garner the harvest of the trade that is attainable. At the same time let us equip ourselves against possible aggression by making ours the most powerful military asset of all, namely—absolute uniformity of standard in world material. In world trade, in world war, and in world education, we *need* meter-liter-gram. It is a vital, desperate need.

There is no time like the present. It is the hour of destiny. We must take up the exclusive use of metric units now. You, the reader of this letter, can help [71]."

In a later pamphlet entitled *Who Suffers?,* Aubrey Drury, the editor/author of this propaganda, took this same line of argument even farther afield.

"Suppose that [due to lack of metric standardization] the war was lengthened only 2 months, what does that mean? It means this: During every month of the World War 100,000 men were killed; 200,000 were wounded or missing. Thus 2 months' delay means the needless killing of 200,000 men; the needless wounding of 400,000 more. It means that metric standardization would have saved the world the suffering, the poverty, the destruction of earning power represented by these 200,000 deaths and 400,000 injuries.

Need we ask here: "Who Suffers?"

Surely it would not be inappropriate to inscribe somewhere on some monument to heroes of the World War: 'Sacred to the memory of those brave men who will never come back, who were needlessly killed because of lack of world metric standardization [72].' "

Such sentimentality may have won a few hearts and minds over to the metric cause, but it was also tailor-made for the unsympathetic propagandists of the American Institute of Weights and Measures, who sarcastically observed:

"The World Metric Standardization Council . . . [has disclosed] a great international secret. It has discovered that the Kaiser would not have started the World War if England and America had been metric!

Its literature teems with declarations that the continuance of the use of the English system is a menace to the peace of the world, that this war-god should be cast into outer darkness and that then under the benign influence of the metric dove a heavenly peace would settle upon the world, the Lion and the Lamb would lie down together and enemy nations would fall into each other's arms and weep for joy. In this millenium all shooting irons would be made to metric dimensions, with interchangeable parts, so that the nations could shoot standardized metric bullets and men could die, if need be, with a metric smile of content.

. . . Let us illustrate: Behold the brotherly love between metric France and metric Germany. Observe how all the nations of metric Europe are welded together into one great seething, writhing mass of peace and goodwill. 'Keep the World War Won by Adopting the Metric System,' shrieks the World Metric Standardization Council, standing astride the Rhine and viewing the landscape o'er [73]."

But there was no need to feel sorry for the World Trade Club, for it gave the same treatment right back to its detractors. Posing the question "who opposes meter-liter-gram?" they answered:

"*The profiteers* . . . An element consisting of less than 1% of the people of U.S. America and Britannia—an element actuated by selfish concern for supposed advantage to their own pockets—an element, a clique, apparently intent upon obstructing the military efficiency and the industrial and commercial development of U.S. America and Britannia [74]."

This view of the situation left Mr. Drury with 99% of the population favoring metric adoption, and he was fond of mentioning the names and opinions of as many of these as he could. In fact, he managed to fill a 200-page, fine-print pamphlet with just such material [75]. Emphasizing the point that metric supporters were "practical men" he listed and quoted from dozens of individuals, from the "pre-eminent" (Andrew Carnegie, Alexander Graham Bell and Thomas Edison) to the unknown. Mr. Drury also presented an overwhelming list of chambers of commerce and professional and trade associations which had gone on record as favoring metric adoption. The National Chamber of Commerce was not on his list, although he tried (and failed) to get the Chamber to submit the issue to a referendum vote of its members [76]. The associations mentioned as favorable to the proposition included not only a few large ones, such as the American Chemical Society, the American Medical Association, and the American Pharmaceutical Association, but also a good many less well-known groups, the National Manufacturers of Soda Water Flavors, the National Kindergarten Association, and the Association of Flower and Feather Manufacturers of America, for instance. Virtually no field of endeavor was overlooked by Mr. Drury in his effort to demonstrate the overwhelming demand for "world metric standardization." Although there is no way of judging whether or not such tactics were effective in convincing legislators of the need for metric adoption, Mr. Drury clearly believed that they would work and he devoted a great deal of his attention to this phase of the publicity campaign he was conducting.

Another facet of this same general argument, and the one on which Mr. Drury's claim of a 99% favorable reaction to the proposal was based, was the mass petition effort referred to earlier. As of the end of Ocotober 1921, the petitions received were classified (by Mr. Crocker) as follows [77]:

Classification of Petitions . . . Regarding the Exclusive Use of the Metric System of Weights and Measures

	For	Against
Manufacturers and engineers	15,501	401
Trade	14,589	125
Education	37,244	138
Medical and surgical	11,069	224
Federal and State officials	1,080	8
Agriculture	1,811	17
Accountants	399	2
Attorneys	3,221	52
Vocation not stated	12,674	177
Miscellaneous	4,094	16
Total	101,682	1,160

To the casual observer, this overwhelming "vote" in favor of the metric system would seem to confirm Mr. Drury's claim that only a little more than 1% were opposed to the adoption of it. It should be borne in mind, however, that these results were not the outcome of a carefully designed and controlled public opinion survey but were, rather, the product of a publicity campaign designed especially to elicit this very response. There was not even an appropriate space on the preprinted form for registering disapproval of the idea. Therefore, this "survey" was more representative of the size and composition of the World Trade Club's mailing list than of the status of public opinion on this issue. Nevertheless, the mere existence of so many petitions in favor of metric adoption provided the advocates with a selling point to use at Congressional hearings and in their literature.

Needless to say, the fact that the petitions had been sent to the Bureau of Standards, had been stored there, and had been counted and classified using public facilities was interpreted by the opposition as indicating that the Bureau was underwriting the whole petitioning process. Allegedly, these allegations were totally unfounded. In a letter to acting Secretary of Commerce Ritchie, who had requested an investigation after receiving a complaint from Mr. Dale, director Stratton explained:

"Card 'No. 9' and envelope 'No. 2' were not issued with the approval or knowledge of the Bureau of Standards. Before any such cards were received by mail at the Bureau of Standards, a large number of petitions were sent to the Bureau from the White House for filing. A few were later received direct by mail . . .

The World Trade Club of San Francisco probably circulated the petition forms with addressed cards enclosed. As soon as it was discovered by the Bureau, the Club was at once informed that the Bureau was not the place to address legislative petitions and was requested to discontinue addressing such petitions to it [78]."

But something was amiss. In a letter to Albert Herbert dated June 6, 1919, Howard Richards, Jr. of the Metric Association said:

"I have conferred with a number of government employees and succeeded in having the 'meter-liter-gram' petitions circulated by the World Trade Club sent to the Bureau of Standards. Now this was not altogether easy to do and the matter requires careful handling. Mr. Halsey has been frequently in Washington and spares no opportunity to attack Dr. S. W. Stratton and our other friends who are in favor of the movement . . . . I would suggest that you make no mention of the petitions as yet because it is possible that the administration might order these petitions referred to a special committee and put in charge of someone unfriendly to the metric movement [79]."

As will be seen later, these machinations may not be attributable to Dr. Stratton at all, but to his secretary of long standing, Mr. Henry D. Hubbard. Mr. Hubbard was the primary point of contact at the Bureau for organized metric interests, and there is evidence to suggest that he may have been over-enthusiastic about the extent to which the Bureau should be aiding the cause.

The need for some assistance in sorting, classifying and counting the petitions was acute. With so many of them arriving in such a short time, it would have been impossible for Mr. Richards or Mr. Crocker to have done this job alone, especially with their other duties to attend to. If some of the Bureau's employees were, in fact, actively assisting the petitioning campaign, it would not be unreasonable to assume that they also helped to arrange for clerical assistance. This fact was hinted at by several correspondents, including, Richards, Crocker, and Drury, but it cannot be verified absolutely. Eventually the petitions were transferred to their rightful home, the Committee on Coinage, Weights and Measures, where they sat in 13 file boxes in the committee room as a constant reminder of the uncompleted reform.

Mr. Drury's most ambitious undertaking was the compilation and publication of his "big book"—*World Metric Standardization: An Urgent Issue*. This book, which sold privately for $5, was given away free to schools and libraries and did not prove to be much of a fund raiser. Nevertheless, it was what it purported to be, "a volume of testimony urging worldwide adoption of the metric units" and, more than any other single document, it chronicled the pro-metric crusade of this era. It contained, in revised form, much of the material already published by the various pro-metric groups and individuals, including the lists of metric supporters and the condemnations of "German anti-metric intrigue" already mentioned. It also contained an extensive bibliography of pro-metric literature and articles (one of Drury's favorite slogans was "Look it up"), and a full chapter on the cost of metric standardization.

Although no overall estimate of the cost was made, dozens of authorities were cited as evidence of how simple and cheap metric adoption would prove to be. If any firm did indeed find that the cost was prohibitive, Mr. Drury proposed that "these concerns should be licensed to use the old weights and measures until all equipment made on the old base may be worn out." The important thing was not to delay the needed reform merely to suit the convenience of a few companies. Mr. Drury did, however, supply figures estimating the loss to the U.S. and Great Britain that was resulting from *not* adopting the metric system. This loss he estimated at about $774 million annually and over $33 billion in total since 1783, the year in which Watt was alleged to have invented his decimal system [80]. The greatest single loss was reported to be in the educational field, $441 million annually. Other major losses were attributed to "waste of human life, time and energy," world trade, and other business enterprises. The reliability of the advocates loss estimates can be judged by the fact that they were based on educated guesses and on such esoteric considerations as the "loss in earning power due to driving out children from schools by difficulties of arithmetic as now taught" ($25 million annually) [81]. For the most part, the cost estimates made by the opponents were much more down-to-earth, although figures were publicized only for those few selected companies that had taken the trouble to calculate their costs.

Probably the greatest influence exerted by the World Trade Club's literature was not on legislators, but on periodicals and trade journals, especially those published for scientists, engineers and educators. Throughout 1922, for example, a running debate between various metric advocates and Mr. Halsey appeared in the pages of *Science,* the journal of the American Association for the Advancement of Science [82]. Other publications in which metric publicity frequently appeared included *Scientific American, Valve World,* and *School Science and Mathematics.* The extent to which the appeal of the World Trade Club was picked up by other editors as "good copy" is illustrated by the following extract from the October 1920, issue of a magazine called *GRIP*!

"Let us unite in securing the exclusive general adoption of the metric system of weights and measures. Let each do his share in providing for America the blessings of this long-sought essential, which will mean the greatest forward step of this era and the conferring of incalculable benefit on the nation of today and the generations now rising and to follow.

. . . [A] year and a half of the child's school life can be saved by the exclusive adoption of the metric system in our schools.

. . . The Allies were hampered and delayed—200,000 soldiers were needlessly killed and 400,000 needlessly wounded—because the war was prolonged by the lack of coordination in the units of weights and measurement.

. . . Our great export trade secured during the war can be held only by keeping abreast with other nations in matters of standardized packages, sizes, weights and measurements.

. . . The Bureau of Standards at Washington under the able management of Director Samuel W. Stratton, is using every means at its disposal to enlighten the public on the metric system and to encourage its general adoption.

. . . To give all the statements supporting the metric system would be to publish the representations of 99% of mankind [83]."

The World Trade Club, however, was not the only active group supporting metric adoption at this time. The Metric Association was equally interested in seeing the reform approved, it just went about its advocacy in a different way. The most noticeable difference was that the Association was much less publicity-minded than the World Trade Club. It did advertise its views, of course, but its literature was calmer in tone and more reasonable in its arguments. An occasional newspaper article, a few descriptive brochures and reprinted speeches [84], and the organization's annual reports made up the publications program of the Association during the first 6 years of its existence. The obvious reason for this difference was that the Metric Association did not have sufficient funds to mount a large-scale propaganda effort even if it had chosen to do so, which it probably would not have done. It was not a one-man publicity show but was, rather, a society comprised mainly of professional people and educators. For this reason, the Metric Association concentrated on increasing the actual, voluntary use of the metric system throughout society and on building a convincing case to present to Congress if and when the opportunity arose.

Individual Metric Association members, such as Mr. McEachren writing in *The Valve World* and Arthur E. Kennelly writing for a variety of professional society journals, did a great deal to publicize the pro-metric cause and to boost the activities of the Association. The beauty of this approach, of course, was that it was all accomplished without cost to the organization. It also struck home harder with the opponents of the system, because the articles were more respectable and less open to ridicule than was the material put out by the World Trade Club. Perhaps for this reason, the sharp-tongued publicists of the American Institute of Weights and Measures concentrated their attack on "the San Francisco pro-metric propaganda," and were less harsh less often in their accusations concerning the Metric Association.

Unlike the supporters of metric adoption, the opponents did not have to wage a campaign to accomplish their goal. All they had to do was to knock into a cocked hat the claims advanced by the "reformers." But the opponents were not satisfied just to sit back and await each new pro-metric onslaught, and they were as active as the metric enthusiasts were in promoting support for their cause.

3. THE ANTI-METRIC DEFENSE

The statement that without a strong pro-metric campaign there would have been no need for an American Institute of Weights and Measures is a truism. But there is no better way to explain why the Institute was constantly complaining that metric supporters, or "the metricites" as they called them, were on the verge of success. Once the Institute had been formed and made into a going concern either a total victory had to be won or some other reason for its existence had to be found if the organization was to avoid a premature collapse. Charles Latimer and his adherents in the 1870's and 1880's had had their faith in "pyramidology" to fall back upon. In a similar manner, the American Institute of Weights and Measures made issues out of berry basket and apple barrel bills, Federal regulation of weights and measures proposals, and the administration of the National Bureau of Standards when there was not enough pro-metric activity to warrant a major English-system defense. Such a situation had confronted the organization during its first 2 years, and it would return after 1927. In between, however, the Institute had few problems in convincing would-be sponsors that anti-metric activities on a large scale were essential to the protection of their rights and interests.

Beginning with Luther D. Burlingame's replacement of Mr. Halsey as the group's secretary in the spring of 1920, a time which also happened to coincide with the World Trade Club's intense campaign, the Institute flourished. In January of that year, publication of a quarterly *Bulletin* was initiated, a formal "publicity service" was created, the number of pamphlets produced was increased, and the second edition of Mr. Halsey's *The Metric Fallacy* was released.

But the problem of obtaining additional support for the Institute's work had to be tackled first. To this end, a concentrated membership drive was conducted in late 1919 and early 1920. A very direct appeal was used:

"Do you want to be compelled by law to abolish the use of your present system and substitute the metric system as the sole and exclusive standard weights and measures in your plant and to suffer the endless disorder and confusion and the enormous cost which such a radical change would entail?

If you do not, then turn in and help the American Institute of Weights and Measures fight this foreign invasion . . .

The American Institute of Weights and Measures . . . is conducting a counter campaign against the active and insidious propaganda of the metric party, which is flooding the country with literature, press items and 'news letters.'

Do not go to sleep, delay action and permit radicalism to control such a fundamental of your business as your established standard of weights and measures. Therefore join forces with the Institute, the only association specifically organized and equipped to carry on the fight. You know there is only one way to put through a winning campaign and that is to get behind it and boost it along. If the Institute fairly represents your sentiments we urge you to take out a membership, not as a charity, but as a business policy, an insurance and in a broad sense as a public service. Surely if the interests which would be seriously affected do not support the Institute, no other can be expected to do so [85]."

Although Mr. Burlingame was to serve as the organization's secretary only until September 1920, when he was replaced by Charles C. Stutz, he made significant progress toward building up stable membership support and increasing the effectiveness of the Institute's endeavors during those months. As reported in the second quarterly *Bulletin*, issued in April 1920:

"[Our] Membership Campaign is proving so successful that we have sent a second appeal to members who have not as yet sent us lists of names urging them to do so . . . If we can have continued cooperation we can easily double our membership . . .

We are pleased to see a gradually changing sentiment in the attitude toward the Institute and its work, a feeling that we are helping manufacturers to protect their vital interests and a readiness to cooperate rather than the old feeling that we are putting a burden of cost or time on them which they seek to avoid.

The extreme activities of the so-called 'World Trade Club of San Francisco,' with its liberally financed but meretricious propaganda, can largely be credited with this change, and it is gratifying to see the marked reaction shown, on the part of experienced men and those who know the facts, against the specious and 'catch penny' literature sent from that source. When exposed by a presentation of the real facts such methods can but prove to be a boomerang to discomfort and bring defeat to those that use them . . .

We are now in correspondence and conference with many hundred manufacturers relative to membership; with newspapers in publicity work; with national and local organizations in order that they may be in possession of the facts, to offset the visionary and disingenuous statements of some of those pushing for metric legislation. This means an extensive mail campaign and much printing [86]."

One such publicity effort had already begun. It involved the issuance of several new pamphlets and leaflets, most of which were intended to counteract similar publications by the World Trade Club. This was made obvious in many of the titles selected: *Endorsements That Count, Metric Belief Versus Metric Fact, "Simplifying" Our Weights and Measures, Why Force Us to Speak A Foreign Language, The Metric Agitation, The Metric System Condemned by Those Who Know,* and *The Six Metric Myths*. Even the techniques used were similar. In the pamphlet entitled *The Metric System Condemned by Those Who Know* [87], for example, Mr. Drury's passion for enumerating and quoting from authoritative sources was adapted to the anti-metric case. John Quincy Adams' views were liberally cited, as were those of many lesser individuals who had testified before Congress in opposition to metric legislation over the last 50 years. *The Six Metric Myths* were said to be like the story of George Washington and the cherry tree – not factual, but widely accepted because of endless repetition. The author then set out to explore these myths, which were that:

"1. The system is in universal use except in the United States, the British Empire, and Russia, and frequently Russia is placed in the metric column.
2. The adoption of the system is easy and the transition period short.
3. There exists a confusion in our weights and measures and the system should be adopted in order to get rid of it.
4. The system leads to an important saving of time in calculations.
5. The system leads to an important saving of time in primary education.
6. The adoption of the system is important in the interest of foreign trade [88]."

This particular pamphlet was written by Mr. Halsey, whose views on this matter had been expressed many times: "The metric system universal! In mechanical manufacturers the English system is the overwhelming, preponderating standard of the world." A subsequent pamphlet issued by the Institute listed *Some Reasons for Opposition to Compulsory Introduction of the Metric System*. The person responsible for this tract found that objecting to six pro-metric assertions was not enough. Instead, he identified a full 57 objections to adopting the metric system, most of which were contained, either explicitly or implicitly, in Halsey's refutation of the "six myths."

Halsey's swan song as an active officer of the Institute was the rewriting and publication of a new edition of his book, *The Metric Fallacy*. His stated intention was to confront Congressional Committees with it as "evidence" of the size and strength of the opposition to proposed legislation, thereby putting an end to metric agitation. Mr. Dale was not so optimistic about the chances for success of this project, and he wrote Halsey to that effect in February, 1919, saying:

"As for the new edition of the Metric Fallacy, I beg of you to forget it. It would be living in the past, trying to make history repeat itself. The first edition had no particular effect on the Committee fifteen years ago, that is, nothing anywhere near in proportion to the labor and cost of preparation, and it is not likely that a second edition would be any more effective, particularly if it were the product of pastepot and scissors [89]."

But Halsey had a second, and, to him, more compelling reason for going ahead with the production of his book. As he put it in his reply to Dale: "It seems impossible to get you to understand that I must place before our members evidence of work accomplished in order to secure their continued support, and this book is the only thing I have in mind this year [90]."

This, apparently, was a sufficiently convincing reason, for the new edition of *The Metric Fallacy* did appear in 1920 [91]. Although the earlier chapters were principally a restatement of the anti-metric case which Halsey had been constructing for almost 20 years, the book was not merely the "product of pastepot and scissors." It contained entirely new material dealing with "metric jokers," "berry basket bills," and other alleged, indirect attempts to secure legislative approval of the metric system. Another new chapter, entitled "Specimen Flights of the Metric Imagination," was designed to draw attention to some of the flimsier pro-metric arguments by simply quoting them, and adding a disdainful comment here and there. Another whole chapter, based on material supplied by Mr. Dale, purported to be an "exposure" of the underhanded methods employed by the World Trade Club and its mysterious backer, Albert Herbert, who was referred to only as "Mr. Z." After presenting a chronology of the World Trade Club's propaganda and activities, accompanied by reports on "Mr. Z." submitted by five "investigators," Mr. Dale launched into an indignant condemnation of the San Francisco-based operation:

"For one I wish to enter my protest against this method of manufacturing and misleading public opinion. Before this propaganda to force the metric system on the American people and make it a crime punishable by fine and imprisonment to use our English weights and measures goes any farther, I ask the Committee on Coinage, Weights and Measures to call upon Mr. Z of the World Trade Club to disclose his identity and give all the facts regarding the mysterious and objectionable propaganda he has been carrying on from San Francisco for the past 6 months, in order that the people and their Representatives . . . may know what the World Trade Club actually is and who is or are in back of it.

No individual or group should be allowed to carry on a propaganda under cover of a misleading name, such as 'World Trade Club' for the purpose of exciting popular clamor and by that means, securing the enactment of special legislation by Congress or the Parliaments of other countries [92]."

Such attacks were characteristic of the way in which the metric campaign was conducted during this era. The idea, of course, was to discredit the other side as much as possible and to divert attention away from the real issue—the feasibility and desirability of legislation to adopt the metric system. It should also be noted that the American Institute of Weights and Measures employed many of the same tactics that were used by the World Trade Club. Two primary sponsors of the Institute, for example, were Messrs. Towne and Sharpe, who carefully stayed in the background. Even the name "Institute" and Mr. Halsey's assumption of the title "commissioner" may have been selected in order to leave the impression that the organization was in some way connected to a governmental body. And when it came to publicity, the Institute was neither less prolific nor less emphatic than the World Trade Club.

In fact, one of the first things the Institute did after Mr. Halsey's departure was to create a special "publicity service" with the new funds secured from its membership drive. As noted by Mr. Stutz in 1921:

"Through its Publicity Service the Institute issues four newsletters during each month for wide distribution and in addition prepares articles for publication in magazines, trade journals, newspapers, etc. This service has been conspicuously effective in educating and arousing public sentiment to the dangerous character of compulsory metric legislation. This work is absolutely required if we are to build up and maintain a stable public opinion for the defense of our American standards. It is the most fundamental of any of the activities of the Institute [93]."

The so-called "newsletters" that the Institute produced were, in reality, publicity releases dealing with various aspects of the anti-metric case. Some releases were reproductions of journal articles or parts of letters that the Institute had received from like-minded individuals, while others were formulated entirely by the Institute's staff. Those in the former category were usually issued under a descriptive title, such as "Railroads Oppose Compulsory Metric Legislation," "Colleges and the Metric System" or "Metric Failure Acknowledged in Peru." Those in the latter category were generally given more provocative titles, for instance "Thumbs Down on Metric System," "Shall the Tail Wag the Dog?", "Metric Sophistry," and "The Sugar-Coated Metric Pill," which read in part:

"Since the House Committee on Coinage, Weights and Measures in the spring of this year *failed* to present a compulsory metric bill to Congress, the metric advocates are now telling the public that their aim is:

1. To introduce the metric system GRADUALLY and
2. To urge "Metric Standardization."

To have to do this by law means the compliance to prescribed steps, each with the time limit and each carrying its penalty for disobedience, in other words, *GRADUAL COMPULSION*—compulsion either prompt or gradual still spells compulsion.

The sugar-coating of "GRADUAL INTRODUCTION" and "METRIC STANDARDIZATION" is not a sufficient disguise for the pill itself, which still remains: *"Metric Compulsion"* and *"Scrapping of our present system* [94]."

As in the case of the World Trade Club, the American Institute of Weights and Measures also had a ready-made market for its issuances in addition to eliciting the attention of an occasional newspaper. These included Mr. Dale's magazine, *Textiles,* and other important trade journals such as *Machinery, The Iron Age, American Industries* and *Industrial Management*. Without question, however, the *American Machinist* was the outstanding anti-metric publication of this era. The magazine's policy over the years had been dictated largely by the preferences of its editors-in-chief, as indicated by the fact that it had sometimes been silent on the matter when the debate was at its hottest. But under Frederick Halsey from 1907 until 1911 the magazine had been officially anti-metric [95], and under Ethan Viall from about 1916 to 1925 the *American Machinist* would again be a leading anti-metric spokesman. Between January, 1920 and December, 1922, for example, no less than 50 anti-metric articles were featured in the pages of the *American Machinist,* the majority of these (35) occurring from January-June, 1920.

Many such articles focused on the technical difficulties of metric adoption that were likely to be encountered by the magazines principal readers: shop operators, engineers and foremen. Above and beyond that however, Mr. Viall carried on an extensive editorial campaign that was openly designed to assist the American Institute of Weights and Measures in bringing about the defeat of proposed legislation. This assistance was rendered in various ways. For instance, one of the magazine's regular columns was called "What Other Editors Think," and it highlighted editorials from similar journals. Anti-metric articles that appeared in other magazines were frequently featured in this column [96]. Special material in opposition to the system was also displayed prominently from time-to-time. Letters to the editor, for example, were collected and reproduced in batches under such titles as "What Real He-Men Think of the Compulsory Metric System [97]," and "What Leaders in the Electrical Field Think of the Compulsory Metric System [98]." Mr. Viall also printed letters from several companies who were then protesting the unauthorized use of their names by the World Trade Club in its promotional literature [99].

At the heart of the magazine's position on this issue, however, was a series of editorials written and signed by Mr. Viall himself. The objective was to nullify the World Trade Club's drive to secure pro-metric petitions by starting a counter-movement to generate anti-metric petitions. To achieve this end, the magazine offered to supply appropriate postal cards, in any quantity, free of charge. The cards were addressed to the Chairman of the House Committee on Coinage, Weights and Measures, and said simply: "I am against all legislation tending to make use of the metric system compulsory in the United States [100]." Readers of *American Machinist* were urged to send for enough cards to include one in each piece of company literature and to supply each employee with as many as he wanted. The World Trade Club's cards, it was noted, were being mailed to Washington by the thousand "by doctors, lawyers, school teachers and all sorts of people who know absolutely nothing of real manufacturing or export conditions . . . This dangerous propaganda must be counteracted by the same means the 'millionaire's club' has employed [101]." Unfortunately, the final results of the anti-metric petition campaign were not made public, although some of them may have served as the basis for Mr. Drury's 1921 tabulation showing only 1,160 unfavorable replies.

The *American Machinist* also urged its readers to subscribe money for the Institute's activities. In an editorial entitled "A Watch Dog of American Industry" Mr. Viall exhorted:

> "The pernicious activities and influence of the World Trade 'Club' with its millionaire 'angel' to pay its bills, must be counteracted by telling the TRUTH . . . [T]he American Institute of Weights and Measures must have money to continue acting as the 'Watch Dog of American Industry' in guarding against the passage of foolish compulsory metric legislation . . . Get behind the Institute and PUSH [102]."

This editorial was accompanied by a suitable cartoon which pictured a fero-

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cious-looking English bulldog, wearing the name "American Institute of Weights and Measures" on its collar, standing alertly in front of a door labeled "Entrance to American Industry." The dog was being approached furtively by a masked thug, called "World Trade Club," who was carrying in his hand a bowling ball-like object with a sputtering fuse bearing the tag "compulsory metric bomb." The caption for this cartoon read "This Bolshevik won't get in if you keep the dog in good condition [103]."

As if opposition such as this was not enough to dampen Congressional enthusiasm for metric legislation, the recently-formed National Industrial Conference Board decided to investigate and report on this issue. The chairman of the five-man investigating committee was Mr. E. M. Herr, the president of Westinghouse and a member of the Council of the American Institute of Weights and Measures. Both Mr. Sharpe and Mr. Towne were members of Mr. Herr's committee. Nevertheless, the Board's decision was apparently not a foregone conclusion, for both Halsey and Dale were fearful of a pro-metric report and were discussing between them how best to refute it [104].

The final report *was* a balanced one in that the chief contentions of both sides were presented fairly. After reviewing the origins, development and existing status of the two measurement systems, the extent to which the metric and English systems were used in special fields was reviewed to determine: (1) the factors affecting use, and (2) the feasibility of changing. The special fields considered were science and engineering; agriculture, mining, transportation, and trade; manufacturing; and foreign trade. The Board's conclusion, in summary, was that:

> "[W]ith the exception of pure and laboratory science and wholesale trade and with the exception of certain other industries and fields in countries where the compulsory use of the metric system is generally effective, in practically none of the fields of industry and productive activity of major importance—such as agriculture, mining, transportation, retail and foreign trade and the manufacturing industries—in the United States and in other leading countries has the metric system a widely enough established use or position to readily displace the English or other local systems [105]."

The section of the report that was of greatest interest to the participants in the now-raging controversy, however, was the one dealing with arguments for and against substituting the metric system for the English system. The section was organized according to the key questions to be answered, and both the metric- and English-system proponents' positions were explored in some depth. These questions, which were indicative of how the issue stood just prior to the 1921 hearings, were categorized and stated in the following manner [106]:

A. Intrinsic Merits of the Metric and English Systems

1. Are the fundamental units of the metric system intrinsically superior to those of the English?

2. Is the manner of multiplication and division of units in the metric system superior?
3. Are the units in common use in the metric system fewer and are their names more easily learned and retained than those of the English system?
4. Does the simplicity of structure, indicated in . . . the three preceding questions, make the metric system more comprehensive than the English?
5. In practical use is the metric system more convenient, more adaptable, and more comprehensive than the English in filling the needs that a system of weights and measures is called upon to fill?

B. Advantages and Use of the Metric System as Compared With the English System in Special Fields

1. Is the metric system of advantage and in extensive use in calculations, educational work, technical literature, etc?
2. Is the metric system of superior value and in preponderant use in scientific pursuits?
3. Is the metric system applicable and very generally used in engineering activities?
4. Do the advantages and use of the metric system in agriculture, mining and transportation warrant a change to the metric system in the United States?
5. Do the advantages and use of the metric system in manufacturing warrant a change?
6. Would a change to the metric system be advantageous in domestic trade?
7. Would a change to the metric system be advantageous to the foreign trade of the United States?

C. Practicability of Making a Change to the Metric System in the United States

1. Does the experience of other countries indicate that there would be serious general difficulties involved in making such a change in the United States and what is the relation of compulsory law to such difficulties?
2. To what extent and how would a change to the metric system involve the destruction of established mechanical standards?
3. Would the cost of a change to the metric system in the United States be prohibitive?

D. The Extent and Character of the Demand for a Change to the Metric System in the United States

Is there a demand worthy of serious consideration for a change to the metric system in the United States?

E. Comparison of the Metric and English as Universal Systems

1. Is the metric system used by and large more generally than the English system and has it other greater claims to becoming the universal system?
2. Do the advantages and use of the metric system in certain fields warrant its extension to all fields?
3. Are the chances of adopting the metric system increasing in Great Britain and the United States?

The 1921 version of the answers to these questions was given in the National Industrial Conference Board's Report, with emphasis being placed on the superior strength of the anti-metric, or English arguments. The accuracy of the Board's report would be confirmed during the forthcoming hearings.

Irrespective of the particular answers advanced at that time, however (and most had not changed a great deal from those of earlier years), this set of 19 questions may be regarded as the classic statement of the metric controversy in the U.S., from the very beginning until the present day. Congressional committees have nearly always sought the answers to these very questions, and the success or failure of metric legislation has largely depended upon which questions were accorded the highest priority at different times and which set of participants presented the most convincing replies to the most important ones.

4. THE 1921 SENATE HEARINGS

The climax of the first phase of the 1914-33 metric crusade was the Congressional hearing that both sides had been seeking. Between October 1921, and March 1922, the metric issue was debated before a subcommittee of Senator Robert LaFollette's Committee on Manufactures [107]. This subcommittee was chaired by Charles L. McNary of Oregon, who ran the hearings almost single-handedly. The legislation under consideration was Mr. Ladd's bill,[10] "to fix the metric system . . . as the single standard of weights and measures for certain uses" after a 10-year transition period. As it turned out, the exact provisions of this bill were of no major consequence, because the participants were determined to air all of the aspects of the metric question at these hearings. This was done despite Senator McNary's repeated requests to confine the discussion to the provisions of the bill at hand, but it was probably an inevitable occurrence after the two years of intense campaigning that had preceded the hearings.

These hearings occupied 13 half-day sessions, 10 of which were taken up by pro-metric spokesmen. In all, statements, both written and oral, were received from 39 witnesses, 24 in favor of the bill and 15 against. But the quantity of testimony was not a major factor in the decision that had to be made. The issue was whether or not the supporters of metric adoption could convince Senator McNary and his colleagues that the pro-metric contentions should outweigh the arguments of the opposition.

[10] S. 2267.

Aside from the debate itself, an interesting skirmish developed over the parliamentary procedure to be followed by the Committee in hearing both sides of the issue. The proponents of the bill, who were organized by Mr. Crocker and Howard Richards, Jr. of the Metric Association, were asked to present their case first. This had apparently been arranged by Mr. C. C. Stutz of the American Institute of Weights and Measures, who was in charge of the anti-metric defense. By allowing the advocates to go first, Mr. Stutz hoped to be able to make his case by presenting witnesses to refute the pro-metric side on a point-by-point basis. At first all went according to plan, and both sides had ample opportunity to air their arguments. But Mr. Stutz's plans were shattered later when someone, presumably Senator Ladd, received permission from Senator McNary to present additional pro-metric material in rebuttal to the opposition's original case. After this was done, the hearings were closed and the transcript was printed. But the fate of this legislation was not to be decided on the fine points of parliamentary procedure, either. The bill eventually expired while still in the hands of the Committee.

In presenting their case, the pro-metric forces relied upon three types of witnesses: scientists and educators, businessmen, and spokesmen for organized metric interest groups. The professionally-trained individuals were there principally to explain the system's attributes and the advantages of using it; the businessmen had come to tell the Committee of specific instances in which it had been adopted by their firms and to prove that such a thing could be done cheaply and beneficially; and interest group representatives were anxious to convince the committee that the metric system must be adopted and that the proposed legislation was the right way to do it. It also became clear that metric advocates had learned a lot from the experiences of earlier years. To a man, they all endeavored to present the system's advantages in a practical light.

Dr. H. W. Wiley, for example, former Chief of the U.S. Department of Agriculture's Bureau of Chemistry, not only discussed the comparative advantages of the two systems but also emphasized the metric system's superior features in the fields of education and agriculture. Since Senator McNary had been a farmer, he paid particular attention to Dr. Wiley's views on metric adoption and the farm community, which were that:

> "[T]he farmer, of all businessmen, would be best served by this bill. There is no other business where the confusion in the terms is so great as in what the farmer produces and in what the farmer buys. The idea of what a barrel is, or a bushel or a box, is so vague, so uncertain and so fugitive, that a farmer in one State cannot have any idea of anything more than [what it is] in his own State . . . The moment he goes into another State he finds a different value placed upon it. So there is the utmost confusion [108]."

This statement was illustrated by an accompanying chart, which indicated the variation in weight per bushel of various farm products from state to state. The official weight set for a bushel of unhusked corn, for example, ranged from a low of 70 pounds to a high of 75 pounds, onions ranged from

48 pounds to 57 pounds, and tomatoes from 45 pounds to 60 pounds. The clear implication was that there was a tidy profit to be turned in buying products by weight in one state and selling them by volume in another, although no evidence was advanced to show that such practices were widespread. Still, Dr. Wiley's opinion was that adopting the metric system would provide the basis for eliminating such problems by virtue of the inherent relationship between the units of mass and volume that existed in the metric system.

Speaking for the National Wholesale Grocer's Association, Mr. Arthur P. Williams envisioned a number of economies that would result from metric adoption:

"It will mean the elimination of thousands and thousands of sizes [of cans] that we use today . . .

I believe that with the introduction of the metric system, when all those would be eliminated and we would get down to a standardized package, that the consumers of the United States would save millions of dollars. I do not believe the average woman knows what she gets when she buys a can that is marked 1 pound 4 ounces, 1 pound 5 ounces, 1 pound 7 ounces [109]."

On an even more practical note, Mr. Theodore H. Miller, works manager of the DeLaval Separator Company in Poughkeepsie, New York, related his firm's experience in actually changing their operations over to the metric system:

"With us this is not theorizing, this is not an academic discussion; we have done it. We have a very complete and efficient system of cost accounting. The cost of changing over to this system cannot be found in the product.

. . . [W]e simply changed the figures on the drawings and gauges most constantly in use. I want to emphasize the fact that we changed the size of nothing [110]."

Additional testimony along these same lines was supplied by Mr. S. M. Vauclain, the president of Philadelphia's Baldwin Locomotive Works, the Nation's largest firm in this field at the time:

"[W]e seldom know how good a thing is until we get to use it. We first object to it. Later on we embrace it and swear by it. That might be the case here. I remember when we were first asked to quote for locomotives in the metrical system of measurement all my partners threw the drawings down. I said, 'Why not? We will never learn sooner, and I propose to build these locomotives exactly in accordance with these drawings.' And it did not cause us the slightest inconvenience. The bugaboo of tremendous mistakes, spoiled work, and everything of that sort faded. We did not have them [111]."

But Mr. Vauclain was not enthusiastic about the proposed bill before the Committee, primarily because he felt that it wasn't strong enough. He pointed out that the legislation contained no provisions that were directly applicable to manufacturers and objected that "everybody could keep right on making anything that they pleased except that . . . they would have to bill it out in metric equivalents [112]." Instead of this, Mr. Vauclain preferred legislation of the type proposed 20 years earlier, under which the metric system would have been made obligatory on Government departments. This course, he felt, would eventually lead to the desired end of gradual adoption by the rest of society.

The executive branch of the Government, however, was certainly not in agreement on the desirability or feasibility of increasing the use of the metric system at this time. Mr. Henry D. Hubbard and Mr. H. W. Bearce, giving the views of the Bureau of Standards on this issue (Dr. Stratton did not make an appearance), attested to the advantages of the metric system in the Bureau's work and gave examples of the beneficial impact that metric adoption might be expected to have on the rest of the Nation. The U.S. Army and U.S. Navy, on the other hand, sent representatives to present opinions in opposition to the bill. In both cases, the agencies' stands were based upon reports submitted by subordinate bureaus, which were fearful of the cost of changing and of the possible effect on the country's military preparedness. The Navy Department's overall opinion was illustrative of such objections:

"While academic reasons might under normal conditions justify this change which would be far-reaching in its effect upon the material used by the Navy, the conditions of the business of the country makes the present time inopportune for pressing the passage of the bill. Furthermore, before this country finally decides to adopt the metric system, the other English-speaking nations of the world should be approached in an effort to secure joint and simultaneous action . . . The opportune time for the passage of such a bill would be when the country is in the full flush of a period of great commercial prosperity, when the burden of expense incident to the change would not be so deadening in its effect upon business.

The expense to the Navy Department, of adopting the metric system would be very great even if spread over a 10-year period [113]."

With the exception of these two negative opinions as to the desirability of the bill, and allowing for the extra emphasis that was being placed on practical considerations involved in adopting the metric system, the pro-metric case followed the by-now traditional pattern of calm logic that had evolved over many decades of attempting to secure favorable legislation. Even the representatives of organized pro-metric interests, Howard Richards and Aubrey Drury, were brief and to the point in their initial statements.[11]

Senator NcNary, however, was apparently not being persuaded that the bill ought to be passed:

"It is quite apparent that apothecaries, manufacturers, and engineers over the country, are in favor of it, but they are a very small percent

[11] Mr. Drury's was submitted in writing.

of the great mass of people. Of what advantage is this system to the average individual engaged in business; and how long would it take such an individual to adopt the system, and would he do it graciously? Those are practical questions . . . We are forcing a great change upon the public for a few people who would benefit by the change. It is from that standpoint that I want some discussion of the subject [114]."

Furthermore, Senator McNary perceived that several alternative ways of accomplishing the same end were available to the Nation, including: (1) the passage of uniform State laws adopting the system, especially for educational purposes; (2) letting the Government take the initiative; or (3) approving the bill as it was then written. He simply wanted to know why the third alternative was considered preferable. When Mr. Richards tried to answer him by stating that it was the one the people wanted, citing the 103,000 petitions as evidence, Senator McNary countered:

"That is not the answer at all, if I may be pardoned for saying so. Propaganda is one thing . . . [but] you have not reached the masses yet by any evidence that has been presented here. I do not suppose there are five farmers in North Dakota that know anything about this system . . . I mention that State because my good friend, Senator Ladd, is here, and who has introduced this bill with the idea, and a very laudable one, to change around to this system. I can see the advantages of it, at some time and some place, as I can see the advantages of an international dollar . . . But the problem is, how to approach these things. Must it come through evolution or must it come through enforcing legislation, and if so, how? That means more to me than all the tables you can present [115] . . ."

If the proponents of the bill were not able to supply good answers to these questions, the opponents were more than happy to do so. To begin with, Mr. Stutz filed a 50-page brief in opposition to the legislation that had been drawn up by the American Institute of Weights and Measures. Following his predetermined plan, Mr. Stutz's brief contained a point-by-point rebuttal of the statements made by pro-metric witnesses. In answer to the plea that a change would be inexpensive, for example, the Institute presented figures showing: (1) that the cost to each artisan would be at least \$2.50 (for masons and blacksmiths) and could go as high as \$32.60 (for tool makers); (2) that the cost to each household of replacing common measuring tools would range from \$2.90 to \$10.75, and that, with 28 million households in the country the minimum cost would be \$81.2 million; (3) that the bill would impose hardships on the farmer by destroying ingrained relationships built up over time (such as price per bushel or per pound) and forcing him to use a mixture of two systems; (4) that the railroads would have to change all freight and passenger tariffs, entailing great expense and causing confusion; and (5) that the cost to manufacturing firms alone would be astronomical if an Institute survey of 31 firms, which had yielded an average cost of \$715,489 per firm, was any indication [116].

This method of presenting testimony, i.e. by filing prepared written statements, was used almost exclusively by the opposition's witnesses. Most of them appeared before the Committee in person to answer questions, but their well thought out arguments and supporting evidence was contained in these "briefs" that were simply handed to the Committee for inspection and inclusion in the printed record of the hearings. Other briefs, for example, were filed by Mr. Halsey (who stressed the "failure" of metric adoption attempts in other countries); the Cleveland Twist Drill Company (which estimated that it would cost them almost $454,000 to convert to metric operations); William C. Wilson, the Institute's counsel (who discussed the political dangers of enacting radical legislation, among other things); Samuel Russell, the framer of the decimalized English system bills; and Samuel Dale.

Mr. Russell, who had really come before the Committee to advocate the substitution of his own bill for the Ladd bill, attacked not only the principle of metric adoption but even those who were supporting it. In so doing, his arguments and general tone were more than a little reminiscent of those used by Charles Latimer and the International Institute more than 30 years earlier:

"We are fortunate . . . in this free country that there is no bolshevist directory to impose the metric system upon the country by arbitrary decree as was done by the communist directory of the French Revolution at the close of the 18th century. The American people don't want the metric system and the people cannot be compelled to accept this futile thing for they have the power to elect a Congress that will respond to the consensus of public opinion upon this great question.

The English language, English law and English measures are the heritage of the people . . . They exist by inveterate custom and universal consent. And they exist independent of the force of any statute or enactment of legislation. They are not to be abolished by arbitrary statutes . . .

The greater the fallacy, the greater the number of volumes that may be printed about it. Thus the literature of metricism is second only to that of socialism, single taxism, and of other fallacies which never lack adherents and advocates. It may be said that all fanatics are sincere, the metric fanatics with the rest . . . [but] Sincerity, zeal and assiduity are . . . not to be taken as proofs of the soundness of any cult, cause or propaganda.

It is said by some that the metric system is inevitable and that its adoption would otherwise be a desirable thing for the country. The truth is that the metric system is neither inevitable nor desirable. There are, moreover, no adequate or even sound reasons, and certainly no advantages, for its adoption in a great commercial country like the United States . . . There is nothing behind this metric movement but the stimulation of artificial propaganda. If the propaganda would stop, the whole scheme would die down and die out. Outside of the few zealots who either from motives of pay or passion, carry on this agitation, the great mass of emotionalists who have given a nominal endorsement to the metric scheme, are in fact indifferent about it and respond only to artificial stimulation . . .

Of all the sickly sentimentality that is indulged in by metric zealots this claim that the metric system has anything to do with peace or disarmament is the limit of gratuitous assumption. The peace of the world in the present posture of international affairs depends upon the unity of English-speaking peoples and the spread of English liberty, English letters, English law, and English measures throughout the world. And the duty of the American people is to retain inviolate our Anglo-Saxon heritage, both for ourselves as well as for the benefit of all the nations, and for the expansion of trade and peace throughout the world.

And as for the metric system, let us consign it to innocuous desuetude [117]."

It should be emphasized that Mr. Russell's views were typical only of a very few anti-metric people. His testimony was neither given on behalf of nor sanctioned by the American Institute of Weights and Measures. Before Congressional committees, at least, the Institute did not choose to fight the battle on that level.

Mr. Dale's conclusions, on the other hand, were typical of the message that the Institute was trying to communicate:

"Summing up the truth about the English and metric systems, we find that the introduction of the metric system by education is a failure; that its introduction by making it the standard for Government business is a failure; that laws forcing the people to use it are out of the question; that any partial success in introducing the metric system by any of these three methods is certain to cause the incurable confusion of double standards, for once introduced it will be impossible to get rid of the metric system, as it is now impossible to abolish the English; that as a matter of fact the English system we now have is far superior to the metric system it is proposed to introduce; and that consequently it is a duty that we owe to posterity to protect our established English system so far as possible against any and all mixture with the metric or any other alien system [118]."

That, stripped to its bare essentials, was the case presented by the opponents of metric adoption.

In presenting their case in rebuttal to the opponents' stand, the supporters of the Ladd bill adopted the technique of submitting written briefs. They also pulled out all the stops in an effort to convince the Committee that there was a significant demand for metric adoption: dozens of supplementary letters were filed, names of hundreds of supporters were listed, and many pro-metric resolutions that had been passed by various organizations were reprinted. Most of this material was contained in a 97-page statement written by Mr.

Drury that was little more than an abridged version of his forthcoming book, *World Metric Standardization.*

As already noted, however, the quantity of testimony supplied was not a major factor in determining the outcome of the Ladd bill, and Senator McNary was well aware of the methods that had been used to secure much of the "evidence." It cannot be said that the opponents managed to defeat the bill. It was just that the supporters of it were not able to convince the Senate Committee on Manufactures that the opposition was ill-founded and that the bill ought to be enacted. As a result, the Committee did nothing and the opponents had carried the day once more. This did not, of course, put an end to the issue. It merely forced the advocates to withdraw and regroup.

D. THE FINAL ATTEMPTS (1923–1933)

Before the great metric crusade ran out of steam those advocating the passage of legislation would get several more chances to successfully execute their program. The decisive round came in 1926 when, after hearings by the House Committee on Coinage, Weights and Measures, the proponents failed to muster enough votes to secure a Committee report in favor of the bill at hand. Although the campaign weakened rapidly after that, the events leading up to these hearings were almost as numerous and noteworthy as the activities that had taken place between 1919 and 1921.

1. LEGISLATIVE TRENDS

In the next few sessions of Congress metric legislative proposals were modified slightly in an attempt to blunt the contentions of the opposition and formulate a bill that would be acceptable to Congressional leaders. Mr. Britten's *H.R. 10* of December 7, 1925, was characteristic of this type of legislation.[12] It provided for "extending the use of metric weights and measures in merchandising . . . from and after the 1st day of January, 1935." It further specified that the metric system was to be used in:

1. Buying or selling goods, wares, or merchandise, unless permission to use other weights and measures has been granted by the United States Department of Commerce or by a State department of weights and measures or by an authorized State official.
2. Charging or collecting for the transportation of any goods, wares, or merchandise, unless permission has been granted to do otherwise by any of the authorities designated above.
3. Postage, excises, duties, and customs charged or collected by weight or measure by the Government of the United States of America.

Specifically exempted from the requirements of the Act were:

"1. The construction or use in the arts, manufacture, or industry or any specification, drawing, goods, wares, merchandise, tool,

[12] In a similar vein were H.R. 10 of Dec. 5, 1923 and S. 100 of Dec. 6, 1923 (68th Congress, 1st Session).

machine or other appliance or implement designed, manufactured, constructed or graduated in any system of measurement.

2. The ordering, buying, or selling of manufactured articles, such as tools, machines, or parts of machines ordinarily known by or designated in terms of any other system of weight or measure.
3. Any contract made before January 1, 1935.
4. The survey or description of lands within the jurisdiction of the United States of America, or transactions in lands or real estate therein.
5. The sale of goods, wares, or merchandise originally intended for any foreign country."

The bill also contained one other innovative provision which clearly indicated the influence of the remnants of the World Trade Club:

"After the 1st day of January, 1935, the terms 'world yard' for the 'meter;' 'world quart' for the 'liter' and 'world pound' for 'five hundred grams' shall be recommended for international use and accepted as metric terms."

This type of bill was indicative of the lengths to which metric supporters were willing to go to get a bill (any bill) passed into law. From the above provisions it can be seen that the only activities that would have been affected in a compulsory way were "postage, excises duties and customs" work of the Federal Government. All other fields were either ignored, automatically excluded, or covered by various "escape clauses." Nevertheless, the metric advocates beat the drum for this legislation as earnestly as they had for stronger versions of it in earlier years.

Following the refusal of the Committee on Coinage, Weights and Measures to take action on this bill in 1926, a variety of other legislative tatics were employed by metric supporters. These will be discussed later in this section.

It should also be mentioned that, for a short time at least, Samuel Russell continued to find Congressional sponsors for his proposal to decimalize the English system of weights and measures.[13] All of these bills expired without formal consideration, however, and they were not a significant factor in the metric debate during the mid-to late-1920's.

2. THE CONTROVERSY RENEWED

For nearly 2 years after the failure of the 1919-21 campaign, the organized pro-metric interests were silent. In fact, the World Trade Club stopped its excessive pamphleteering altogether after the publication of Aubrey Drury's "big book" in 1922. Although the exact reason for this discontinuance was never made public, there are indications that Albert Herbert simply decided to stop pouring money into supporting a tactical approach that wasn't proving to be effective. Whatever the reason, Mr. Drury began to concentrate on

[13] Introduced as: S. 2070, Jan. 17, 1924; and H.R. 5942, Jan. 22, 1924 (68th Congress, 1st Session); and H.R. 10736, Dec. 13, 1924 (68th Congress, 2d Session).

building up sympathy among Congressmen and Senators and on cementing relationships with the Metric Association from about 1923 on. Thereafter the Metric Association served as the main spokesman for organized metric interests while the west coast proponents played a supporting role.

In the autumn of 1922 an event occurred that would alter to some degree the character of the debate during the next few years. In September, Dr. Samuel W. Stratton announced that on January 1, 1923, he would become the ninth president of the Massachusetts Institute of Technology [119]. This gave the American Institute of Weights and Measures the opportunity to try to reverse what they had always claimed was the pro-metric attitude of the National Bureau of Standards by influencing the choice of Stratton's successor as director. In this matter the Institute turned to Mr. Dale for advice, and the suggestions he made to Mr. Stutz became the Institute's official position [120]:

"To my mind it is . . . important to show President Harding that a great mistake has been made for the past 21 years in using the Bureau of Standards as an instrument and headquarters for the promotion of the metric propaganda. If the President could be convinced of this fact and then should make the new director understand that he wanted the Bureau detached from the metric propaganda the personality of the new director would not be of so much importance.

The trouble in the past arose from the fact that Stratton had grown up with the Bureau and became a bureaucratic czar to whom Congress and the executive departments deferred to a great extent. A new man will not possess this prestige and for that reason it will be comparatively easy to put an end to the metric propaganda in the Bureau of Standards if the President should give the word to that effect [121]."

"I am sure that the best plan for the American Institute of Weights and Measures is to avoid any special effort to secure the appointment of any particular man as director . . . If you avoid espousing the cause of any man . . . your position will be greatly strengthened and it will . . . leave President Harding and Secretary Hoover to make the appointment on considerations of the man's ability as a scientist, technician and administrative officer . . .

[P]ut your main effort on getting the policy of the Bureau of Standards changed [122]."

The man chosen to replace Dr. Stratton was George Kimball Burgess, a staff member of the Bureau since 1903 and its chief physicist at the time of his appointment [123]. For about a year, Mr. Dale and the Institute carefully avoided the publication of any further charges against the Bureau while they awaited some indication of what Dr. Burgess' position would be. By December, Dale had decided:

"It is my conviction based on observation during the past year that the Bu-

> reau of Standards is as dangerous an agency for the promotion of the metric system as it ever was under the administration of Dr. Stratton who retired just 1 year ago. In some respects it is more dangerous because the retirement of Stratton has lulled many into the belief that the danger has disappeared [124]."

Mr. Dale did not attribute this problem to Dr. Burgess' own attitude. Rather, he believed that individual employees were carrying on the objectionable activities without Dr. Burgess' knowledge. Nevertheless, Mr. Dale was convinced that the problem continued to exist and he resumed his efforts to put a stop to the Bureau's "pro-metric agitation."

What was actually going on at the Bureau during these months is probably revealed most clearly by a set of notes written by Aubrey Drury after a trip East in the spring of 1923. He had called on Dr. Stratton in Boston and reported that Stratton "was very bitter against Samuel S. Dale." Mr. Drury had also paid a visit to the National Bureau of Standards, where he had talked to the Bureau's secretary of many years, Henry D. Hubbard. Of this visit, Mr. Drury reported:

> "He was overwhelmingly cordial—more so than any seen on the trip. He is a great admirer of the metric campaign conducted from San Francisco . . . He declared that Dr. Burgess was likely to be more active in favor of metrics than Dr. Stratton was toward the last, when he considered him lukewarm and somewhat intimidated. He said, 'Dr. Burgess was long resident in France, and knows the advantages of the metric system throughly. He is fearless and not likely to be silenced.' Confidentially, he spoke with displeasure against the stand of Herbert Hoover.[14] He said, 'Hoover seems to think that we aren't going to discuss this metric advance until he waves his hand. We are not going to let him hold back this progress any longer. It is too big a thing to wait on one man's bidding.' This, of course, is confidential, as Hoover is Hubbard's chief. Hubbard inferred that it was he, and not Dr. Stratton, that wrote the article, "Metric Units in the Export Trade [125] [sic.]"

If the substance of this private memorandum was accurate, it certainly justified many of the suspicions harbored by Mr. Dale over the years and, in particular, confirmed his belief that a few individual staff members were carrying on pro-metric work at that time behind the back of Dr. Burgess. Henry Hubbard had been Dr. Stratton's personal choice for the Bureau's secretary in 1901, and it is quite possible that he had also conducted a lot of pro-metric activity from the Bureau's facilities during these years without Dr. Stratton's knowledge. There can be no doubt as to whether Dr. Stratton was in favor of metric adoption; but it may very well have been Mr. Hubbard who committed many of the indiscretions for which Dr. Stratton was blamed, includ-

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[14] In spite of repeated attempts by Drury and others to convince Secretary Hoover to throw his prestige behind the metric system, Mr. Hoover steadfastly refused to commit himself, the Department of Commerce or the Bureau of Standards to a position on the issue.

ing the episode in 1919 with the World Trade Club's petitions. As to Dr. Burgess' position, it was simply this: he considered adoption of the metric system desirable from the standpoint of achieving national and international uniformity, but he felt that compulsory legislation to achieve it was "inadvisable [126]."

On the whole, however, neither the advocates nor the opponents of metric legislation found much to get excited over in the year 1923. Bills were still being introduced, though, and the American Institute of Weights and Measures was preparing to meet any new challenge. For this reason, and perhaps because the staff found themselves with some time to kill, a new booklet was put together by the Institute and released in May, 1924. Entitled *Our American System of Weights and Measures: Why We Should Keep It,* it was written to appeal to popular audiences. Among other things it discussed the advantages of the English system and pointed out how successful American industries had been in applying it:

"(1) Seventy percent of the world output of steel is manufactured in the United States and Great Britain.
(2) Approximatley two-thirds of the world production of machine tools is made to the inch.
(3) Eighty percent of the world production of screw threads is made to the inch.
(4) The United States manufactures 90 percent of the world production of motor vehicles.
(5) Approximately two-thirds of the commerce of the world in manufactured products is on the basis of the English-American system of weights and measures [127]."

The "metricites," they claimed, were trying to upset this situation needlessly by forcing compulsory legislation upon the American people:

"Perhaps there was never a time when reform movements were so plentiful or so insistent as now . . .

The metricite is a reformer. He wants to reform our system of weights and measures. He has been at it for over a century. Our customary English system has become so abhorrent to him that he sees red whenever he looks at it. It appears to him to be a monstrous relic of a barbarous age. It is a menace to progress. Its continuance is a stigma on 20th century intelligence. It must be uprooted and thrown out—root and branch—by the strong arm of the law. Surely the metric zealot runs true to form [128]."

Five thousand copies of this booklet were distributed to members of the Institute and to various publicity sources in anticipation of a renewed "metric assult." The Institute did not have very long to wait.

Shortly thereafter the first Pan-American Standardization Conference was scheduled. It was to be held at Lima, Peru, in December 1924 for the purpose of establishing "a medium or mediums for inter-American exchange of ideas, thoughts, practices, conclusions, etc. concerning . . . problems of standardization [129]." In other words, it was hoped that some sort of treaty or agreement could be reached under which a process of international standardization for industrial products and related materials could begin. According to Albert W. Whitney, head of the American delegation:

"It is my understanding that the Conference will be nontechnical in the sense that no actual standards will be adopted and no technical decisions will be made and the whole effort will be directed toward the building up of a harmonious sentiment favorable to international standardization out of which a cooperative undertaking may issue [130]."

In spite of this limitation, Aubrey Drury and his associates seized upon the Conference as an ideal chance to further the metric cause by international action. Consequently, the name of his organization was changed once again, this time to "The All-America Standards Council," and he announced:

"Metric advocates declare that the forthcoming event offers an unprecedented opportunity for the United States of America to advance logically to the metric commodity units [for containers and package sizes]. Accordingly, it is being urged that the topic of metric standardization hold prominent place on the program at the Lima conference and that a resolution be passed calling upon the United States of America to standardize with all the rest of the American republics upon the world units . . .

It is confidently expected that, as a result of [such] action . . . the Congress of the United States of America (which also convenes in December) will be moved to enact definite legislation providing for a gradual transition to the metric commodity quantity standards . . . When this transition shall have been brought about, all the American republics will then be on a uniform basis for interchange of commodities [131]."[15]

But Mr. Whitney wanted no part of this issue. In a letter addressed to all three groups interested in the metric system he said,

"I have received inquiries from some of your members about my position on the metric question in connection with the work of the Pan-American Standardization Conference . . .

It is my opinion that . . . the whole question of units of weight and measure should [eventually] receive full and frank discussion, but that it would be a mistake if this subject were brought up for discussion at the present time.

. . . To inject a question which is not only technical but highly controversial into an occasion in which harmony and calm judgment should prevail would tend to divert attention from the more essential purposes of the Conference and perhaps jeopardize its success [132]."

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[15] Except Canada, which Mr. Drury had either forgotten or not classified as a "republic."

Although the subject of metric usage was raised at the Conference, by one of the South American delegates, and was spoken against by Mr. Dale, who was attending on behalf of the Carded Woolen Manufacturers' Association, the subject was disposed of by referring it to a "commission" for study and consideration at the next conference [133]. Mr. Dale did report his belief that the Conference as a whole was almost unanimously in favor of using the metric system for its work. He hoped, however, that the investigating committee would give the opponents ample opportunity "to place the facts about weights and measures before the people of Pan America [134]."

Because of the Conference's failure to take definite action favorable to the metric system and because Congressional committees declined to hold more hearings on the issue immediately, the sense of urgency that Mr. Drury had been hoping to stir up did not materialize. Consequently, 1925 was also a comparatively calm year for metric advocates and opponents. In October, however, an indication of things to come was provided by the Metric Association when it began to publish a quarterly journal, called *Measurement*. This was the first regular publication to be sustained by a pro-metric interest group since the American Metrological Society ceased publication of its *Proceedings* in the late 1880's. The unusual thing is that it took so long for the Metric Association to initiate this method of carrying on a campaign, but limited finances may have been a major obstacle. It is also interesting to note that two of the most frequent contributors of articles for *Measurement* were Aubrey Drury and Henry Hubbard. In fact, the lead article in the first number of this new journal was authored by Mr. Hubbard. Entitled "Measurement: The Master Art," it was a short discourse on the importance of measurement to society and made no reference to the metric system.

In 1926, promotional and other activities aimed at securing metric legislation reached another peak, particularly on the legislative front. This was to be the last real opportunity for the supporters of the metric system to achieve their goal, and, for awhile, it appeared as if they might succeed. After repeated setbacks involving a number of different legislative tactics, however, it became evident that metric legislation was not going to be enacted in this era, either, and the matter was again set aside to await more favorable circumstances.

3. 1926 HOUSE HEARINGS

In February and March 1926, the House Committee on Coinage, Weights and Measures held its first hearings on a metric adoption bill in 20 years. The legislation they were considering was congressman Britten's *H.R. 10,* to extend "the use of the metric weights and measures in merchandising" over a 10-year period. As this bill had only been introduced in December, the scheduling of hearings to begin in February represented very short notice and caught both sides a little off guard.

As might be expected, the American Institute of Weights and Measures charged that the short notice was an attempt to prevent the opposition's arguments from being heard:

"Well knowing the opposition existing in the country to compulsory metric legislation, the only hope of the metric propaganda to push through the Committee the Britten bill lay in their ability to keep the opposition asleep while at the same time bringing into play their limited but persistent forces.

To accomplish this, it was necessary to keep as secret as possible the holding of hearings on the bill they had arranged for, and to divulge this date to their opponents only two days in advance . . .

Through such tactics it was expected to find industry and trade unprepared and unable to properly voice organized disapproval of the bill [135]."

The proponents, of course, replied that they had received no more advance notice than the Institute had, and this was probably true in a formal, official sense. But they, at least, had the advantage of knowing for certain that hearings would be held, and that they would occur early in the year. As indicated by a letter from Mr. Britten to Aubrey Drury of December 18, 1925:

"A line to let you know that I have just talked with Hon. Randolph Perkins . . . and we have agreed to meet directly after the holidays and to set a date for hearings on *H.R. 10.*

Do you think that the hearings should be set for the month of January or do you think (as I do) that Monday, February 1st would be a good date to start our public hearings, prior to which time every member of the committee could have heard from the manufacturers in his district, his state and the country on the important piece of legislation . . . [I]t would be up to someone (or various people) to see that every member of the committeee is not only well posted as to what is going on but they should be communicated with from every direction and great care must be taken not to 'circularize' these communications.

In other words, form letters and stereotyped letters might just as well not be written for they will destroy rather than help our case [136]."

Any advantage that this inside information might have given to the proponents, however, was effectively nullified when the Institute was given until March 18 to prepare its main case (a full 6 weeks after the start of the hearings). It was also compensated for by the fact that all of the pro-metric witnesses were to be heard first, and this time there would be no opportunity to submit lengthy rebuttal material after the opposition had closed its arguments. Mr. Dale saw to that by complaining to the House Committee about the preferential treatment accorded to the proponents by the Senate Committee in 1921 and by calling for a full statement of the proponents case before hearing the opposition's witnesses. "We will be brief," he said, "but we want to be sure their case is all in, so that we can study it and in as few words as possible and in as little time as possible give you a final answer and turn aside all this mass of error and tell you the truth about the weights and measures of the United States [137]."

Beginning on February 1, 1926, then, the second (and most crucial) metric hearings of the great metric crusade were held. Testimony was taken from 46 witnesses, and this time the opponents had the edge—27 witnesses to 19 for the advocates. According to the accounts of both sides, the hearings were well-attended. There was also a great interest shown by members of the Committee, as evidenced by the fact that a majority of them participated in the questioning at least one time.

The "traffic manager" for the pro-metric witnesses was none other than the bill's sponsor, Rep. Britten, and he was the first to speak in its behalf. His testimony was principally a recitation of how many notables were in favor of the metric system's adoption:

"I doubt . . . if there is another piece of legislation anywhere on 'Capitol Hill' that could get back of it the galaxy of big men that this bill has behind it. It has behind it such men as General Pershing, Thomas A. Edison, and men of similar type and standing . . .

Men like Samuel Vauclain, head of the Baldwin Locomotive Works, are behind this bill. Surely, that type of man would not be back of a bill of this kind unless it had some merit to it . . .

Statements coming from men like that to your committee will, of course, be given the weight to which they are entitled. There will be opposition to this bill by those who are always opposed to anything of this kind . . .

This bill is not going to affect the farmer or the real estate man. It gives the manufacturer 10 years within which to make such changes as may be necessary in his equipment. His dies wear out within 10 years. His equipment certainly appreciably wears out in 10 years. During that time he can change from our present system into the decimal system, and the length of time is very largely dependent upon the character of the institution [138]."

With very few exceptions, the pro-metric witnesses that followed bore a much closer resemblance, both in credentials and in testimony, to the metric advocates of two, three and even five decades earlier than they did to those of a scant 4 years ago. Mr. Joy Elmer Morgan, editor of the journal of the ational Education Association, for instance, had this to say:

"I wish everyone could visualize the time it takes to teach our children these confusing systems, and the utter hopelessness of the 2,000,000 children in America trying to study and fix in their minds these units that we ourselves can not remember. With the metric system they would be taught just one thing, and they would automatically known all the rest. They would be taught the meter and its subdivisions. They would know that you could take one-tenth of that meter and square it and you would have the world quart [sic], and that the world quart would have just one kilogram [139]."

Other testimony along familiar lines was given by Charles L. Parsons, Secretary of the American Chemical Society, who told of the resolutions favoring the metric system that the Society had passed and stated:

"We [chemists] use it in our daily life and have used it regularly ever since we were at college . . . We use no other, except as we are forced to do so when we come in contact with ordinary trade and commerce [140]."

Then Dr. J. Finley Bell, an Englewood, New Jersey physician, related how he had successfully introduced the metric system into the children's department of the local hospital in 1919 [141]. Mr. Theodore Miller of the De Laval Separator Company and Dr. Harvey W. Wiley, retired chief of the Bureau of Chemistry, reiterated the testimony they had given in 1921, and another old friend of the metric system, electrical engineer Arthur E. Kennelly, observed that:

"The metric system has made, to my knowledge, remarkable advances in this country during the last 25 years. We are, in my opinion, already in a condition of transition from the original English system of weights and measures toward the metric system. For instance, the units employed commercially and industrially in electrical engineering are all metric in the sense that they are based upon the metric system . . .

The optometrists and oculists use the metric system exclusively in their work of manufacturing and providing lenses for spectacles and eyeglasses. The metric system is used in radio to a very large extent . . .

The question, as it appears to my mind, is not as to whether the metric system should come into use, but only as to what date and when it shall be generally used [142] . . ."

In short, the case still being put forward by the pro-metric witnesses, most of whom were scientists, educators and professional men, was that the metric system was the superior one, that its practical uses were growing, and that its eventual acceptance was only a question of time.

By this time, the anti-metric case had also become "standardized" to a great degree. Mr. Stutz, for instance, listed the individuals, firms and associations who were against metric adoption and gave his views as to why the bill would be "compulsory" in its effect. Mr. Dale told of the "confusion and chaos" that existed in Latin America and elsewhere because dual systems were being employed, went into the details of the erroneous statements made by "metricites," and once again attacked the anonymous "Mr. Z" and the San Francisco propaganda campaign.

The railroad interests turned out in force to oppose the Britten bill. Mr. John R. Leighty of the Southern Railway, for example, estimated the minimum cost to his road as follows [143]:

Additional investment cost:	
Changing mileposts	$1,835,000
Changing tariffs	100,000,000
Changing standard plans	15,000,000
Change in shop machinery, tools, etc. and additional stock of supplies	216,000,000
Total	332,835,000

Additional annual cost:	
Maintenance of property	60,000,000
Six percent on additional investment	19,970,000
Total	79,970,000

Other major corporations and associations also sent representatives to oppose the bill for reasons of cost or inconvenience, including the American Telephone and Telegraph Co., Warner and Swazey Co., the Cleveland Twist Drill Co., and the Westinghouse Electric and Manufacturing Co. Mr. Nathan B. Willians, associate counsel of the National Association of Manufacturers, even ventured a guess as to what the total cost might be:

"The latest figures as to the investment in American industries in this country, as compiled by the Bureau of Internal Revenue in their statistics on income for 1923, show it to be $28,000,000,000, not millions, but billions . . .

And when you calculate that you have a cost of $10,000,000,000 in manufacturing alone in order to convert this country to a metric system, outside of the chaos and the loss and damage and loss of energy and the waste of material and waste of human effort during the process, . . . or the equivalent of what we spent in the last war, . . . you have before you your problem with reference to the subject of expense [144]."

In summary, the 1926 hearings gave very little evidence of any significant change in the standing of the metric issue. In fact, a permanent deadlock seemed to have developed, with neither side willing to give up any ground. Even the participants in the controversy became openly antagonistic toward one another. This was exemplified by an exchange of unpleasantries on the last day of the hearings. It began as Frederic L. Roberts, Treasurer of the Metric Association, was presenting his concluding remarks:

"MR. ROBERTS: I call your attention to those petitions, [i.e. the more than 100,000 petitions secured from 1920-22] and in closing I hope you will consider well the testimony that has been presented and also the mass of evidence that we have attempted to give, where practical men have adopted the system and used it and have not attempted to give estimates or imaginary effects or guesses at this particular problem, but have submitted actual facts and figures, and as I say, I merely close with those few words.

MR. DALE: I want to say . . . that those petitions, if I understood the last witness correctly, were secured by the activities of his association, but I understand and am not quite sure that they were so secured.

Those petitions were secured by a mysterious propaganda that began early in 1919, that was sponsored and supported financially by a man living in a hotel in San Francisco . . . and whom I have called Mr. Z., in my attack on the method of carrying on this propaganda, and whose name I will not mention now, because he has never responded to repeated requests that he state his name, the reason for his propaganda and the source of the money.

MR. [REP.] DOUGLASS: Can you conceive of any financial interest he might have in that matter?

MR. DALE: Yes, sir; the financial interest so well stated this morning and yesterday, and that is, the German interests. He is the greatest living authority as to who is back of his movement. Let him come before this committee and state . . . what is back of the propaganda that began as the World Trade Club, that after my attack . . . was changed to the Foreign Trade Club . . . [and then] to the All-American Standardization Council [sic] . . . which now, gentlemen, within the last 10 days, has been carried on anonymously.

I want to protest most earnestly against the Congress of the United States being misled by such mysterious propaganda [145]."

But this was not the end of the matter for, according to the transcript "further discussion [ensued] which, by direction of the acting chairman, was not incorporated in the record." According to Mr. Dale's account, however, what occurred next went as follows:

"As soon as I sat down, Richards came forward and said, 'I want to protest against having a high-minded and public spirited man abused in the way that Mr. Dale has just abused Albert Herbert. Mr. Herbert is not a German. He is an Englishman, and he has a scar on his forehead which is the result of an injury he received when a boy in England caused by using the English weights and measures. It was then that Mr. Herbert resolved that he would devote the rest of his life to abolishing this English system of weights and measures. 'Now,' he said, 'Mr. Dale attacks this man and I want to say that I have been told that Mr. Dale once wrote a letter offering for $25 to advocate the introduction of the metric system into the United States.'

I had just begun to laugh at the scar on Mr. Z's forehead when the words 'Dale,' 'letter' and 'offer to support the metric system' rang in my ears, and I did not let Mr. Richards get any farther. I took the floor on my own account and put in as earnest and vigorous a protest against such charges being made and put into the record as I could frame. I denounced it as being without a scintilla of truth and demanded that the words be repeated. Richards refused to repeat them, but motioning to the stenographer said, 'They're in the record.'

Then I addressed my remarks to the Committee again and demanded, not as a favor, but as a right, that this affair should be settled at once and that I should know exactly what had been said, in order that I might expose its falsity. One of the members of the Committee said, 'You have already denied it.' I did not have an opportunity to explain to him that what I wanted was a statement of the exact words used by Richards, for the Chairman then said, 'Let the remark be cut out of the record and everything referring to it.' A member of the Committee, who is with us on this question, looked up at me and bowing his head said, 'That makes it all right.'

The affair ended with my offering the anonymous postal card from San Francisco as evidence, and the [acting] Chairman, Thurston of Iowa, saying in an angry, nervous way to the stenographer, 'Don't accept it. Don't accept it.' The Chairman then said, 'I declare the public hearings closed,' and the crowd dispersed, evidently having thoroughly enjoyed the closing scene in the drama [146]."

Mr. Roberts' version of this same affair was more succinct: "the sessions on Friday were quite 'HOT' [146]."

4. THE OUTCOME AND THE AFTERMATH

No report on the Britten bill was ever issued by the Committee on Coinage, Weights and Measures. According to information received by Mr. Dale, the bill was formally set aside by the Committee on April 20, 1926, because of the impracticality of trying to secure enactment of it in the face of such strong opposition [148].

Unwilling to accept defeat, the supporters of metric adoption quickly tried other means to bring the issue to the floor of Congress for a vote. On April 27, 1926, Rep. Lowrey of Mississippi introduced the following joint resolution:[16]

Whereas the metric system of weights and measures is accepted generally for international use; and

Whereas the use of such system is by law required by a majority of the nations of the world; and

Whereas the States of California, Illinois, Tennessee, North Dakota and Utah have memorialized the Congress to enact legislation adopting such system; and

Whereas such system is decimal, practical, easy to learn, and convenient to use; and

Whereas there exists a strong sentiment in favor of universal use of a standard system of weights and measures; Therefore be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Director of the Bureau of Standards is authorized and directed to conduct a thorough investigation and study to determine the advisability of adopting, for general use in the United States, the metric system of weights and measures. Such director after making such investigation and study shall initiate and carry out, to such extent as he may deem

[16] H.J. Res. 238 (69th Congress, 1st Session).

> advisable, plans to encourage the general and common use in the United States of such system of weights and measures.

An identical resolution was introduced in the Senate two days later by Mr. McKinley of Illinois.[17]

To provide an even greater choice of legislation, two more resolutions were introduced about 2 weeks later—one in the House by Mr. Britten and one in the Senate by Mr. Gillett of Massachusetts.[18] The "whereas" portion of these proposals stated (1) that Congress had been given the power "to fix the standard of weights and measures" by the Constitution; (2) that there existed a lack of uniformity in U.S. weights and measures; and (3) that these were not "standardized with the weights and measures used by the vast majority of nations of the world." For these reasons, the Congress was asked to provide that:

> "the United States Department of Commerce is authorized to establish commodity quantity units for general use in merchandising after 1935, standardizing the yard to the meter, the quart to the liter, the pound to 500 grams, decimally divided."

For most of 1926, then, there were five different metric proposals pending before Congress. This fact, and the controversy that had been generated at the February-March hearings, caused a revival of general interest in the subject. The April, 1926, number of *The Congressional Digest,* for example, was devoted almost entirely to a discussion of the pros and cons of the issue [149]. After explaining the metric system and its legal standing in the United States, the magazine featured articles treating both sides of the question that had been prepared by the leading exponents. Presenting the case in favor of adoption, for example, were Mr. Britten, Frederic Roberts, Major Fred J. Miller (past president of the American Society of Mechanical Engineers and former editor of *American Machinist),* Godfrey Cabot (president of the National Aeronautic Association), Samuel Stratton, and others. Representing the opponents' position were Congressman John Wolverton of West Virginia, Alfred P. Thom (of the Association of Railway Executives), Frederick A. Geier (president of the Cincinnati Milling Machine Company), Mr. Stutz, Mr. Herr, and spokesmen for a number of other associations and corporations.

Similar treatment was given to the metric question in a volume of the H. W. Wilson Company's "Reference Shelf" series [150]. This book, entitled *Metric System,* outlined the arguments for and against adoption, provided an extensive bibliography of other works on the subject, and included numerous reprints of articles dealing with various aspects of the question—Pan-American standardization, shop practices, comparative merits of the two systems, and so forth.

But an increase in general public interest was not sufficient to force action on any of the pending measures. The Lowrey Resolution, according to information given to Mr. Dale by Congressman Douglass of his district (Boston,

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[17] S.J. Res. 105 (69th Congress, 1st Session).

[18] H.J. Res. 254 and S.J. Res. 107 (69th Congress, 1st Session).

Massachusetts), was voted down by the Committee on Coinage, Weights and Measures on April 29, 1926 [151]. In early December the Senate Committee on Commerce held brief hearings on the two resolutions that were pending, but no action resulted and the hearings were not even printed.

Aside from the fact that the American Institute of Weights and Measures was unalterably opposed to *any* metric legislation, the reasons why they opposed these particular resolutions were clear. In the first place, the Institute could not have been expected to agree with some of the assertions contained in the legislation—the statement that "whereas such system . . . is easy to learn and convenient to use" for example. The opponents had been challenging the veracity of opinions such as these for over 10 years. Even more important to the opponents, however, was the fact that the ultimate decision on this matter would have been left to the Commerce Department, and the National Bureau of Standards in particular. Mr. Dale found this especially distasteful [152], and he later reiterated his reasons:

"In the consideration of questions relating to weights and measures there is great danger of placing too much confidence in the Bureau of Standards. That Bureau is dealing with highly technical and scientific questions on which very few people . . . are or need be competent to pass judgment. Furthermore, during the 23 years of its existence, there is no record of this bureau having been subjected to a rigid inspection by a corps of independent, impartial and competent experts. Successive Congresses have accepted the Bureau of Standards as the last word in excellence and have contented themselves with making steadily increasing appropriations for its support . . . Congress is not doing its duty to the people when it accepts so much on mere authority without having the pretensions of the bureau subjected to regular and adequate examination . . .

The concentration of power in bureaus at Washington necessarily means the loss of power by the people, and if this tendency is not checked the inevitable result will be to make the Government a bureaucracy, with the power in the hands of bureau chiefs and their subordinates, who for all practical purposes will be independent of the people over whom they rule [153]."

Addressing the National Conference on Weights and Measures in 1928, Dr. Burgess made an emphatic reply to such accusations:

"In relation to all proposals advocating the compulsory adoption of the metric system of weights and measures in the United States the policy of the Bureau of Standards is one of neutrality—neither to advocate nor discourage. The whole subject of compulsory adoption is a highly controversial one and diametrically opposite views are being freely voiced. Most of these are matters of opinion and definite facts are very difficult to obtain. So many factors enter into the equation . . . that the Bureau is disinclined to make the attempt to evaluate it and thus throw the weight of its decision upon the one side or the other.

Therefore I can say definitely and emphatically that the bureau is not advocating the adoption of the metric system for commercial or industrial uses whether by legislation or otherwise. Moreover it has never done so during the period that I have been director of the bureau [154]."

This peripheral issue not withstanding, the resolutions proposing to turn over the metric question to the Bureau for study and a final decision got nowhere. For several more years, the proponents kept the issue barely alive by a combination of resolutions being introduced similar to the 1926 proposals,[19] the continued publication of quarterly journals, and an occasional special publication [155]. The American Institute of Weights and Measures, of course, continued to publish their journal and to oppose metric legislation for as long as the advocates remained active.

But interest in the issue was gradually waning. It became increasingly obvious that no satisfactory resolution of the problem could be achieved by legislative action, and alternative approaches, such as encouraging voluntary use of the system, were not proving to be as effective as the metric enthusiasts had hoped. By the time the great depression struck, the metric question was nearly a dead issue anyway, and the financial crisis simply put the finishing touches to it. By 1931, both the Metric Association and the American Institute of Weights and Measures had ceased active work, and the efforts of San Francisco-based campaigners had long since ground to a halt. Of the three interest groups involved, only the Metric Association would survive to participate as a group in later discussions, but Aubrey Drury and some of the men connected with the Institute would continue to debate the issue as individuals for many years. By 1933, however, all activity connected with the great metric crusade had ended. In spite of a very large investment of time, money and personal dedication by an unprecedented number of people, the advocates had once again failed to attain their goal of securing legislation to adopt the metric system as the official system of weights and measures in the United States.

E. RECAPITULATION

Even though the ultimate goal of the metric advocates had not changed from that of earlier decades, a drastic alteration in the main strategy for achieving it made this era in the history of the metric system in the U.S. a distinctive one. Whereas previous metric campaigners had focused on educational and Governmental institutions as the desirable mechanism for introducing the metric system to the public, the prime movers during this era took their case directly to the people. The primary aim of the great metric crusade was to sell the metric system to the public by means of promotional literature in the hopes of raising a great popular demand for the enactment of applicable legislation.

This approach resulted in a number of previously-used techniques being carried to an extreme and also gave rise to the utilization of several new

[19] For example, H.J. Res. 124 and H.J. Res. 125; Oct. 28, 1929 (71st Congress, 1st Session).

ones. There was nothing new in the formation of special interest groups to debate the issue, and not even the existence of three of them at one time was unusual. But earlier groups had been chiefly local, or at best regional, in scope. In contrast, the special interest groups of this era were truly national in character, one of them even being located on the Pacific Coast. That one, the World Trade Club, was also unique among metric organizations in that it was not a club or society at all, but a publicity campaign masquerading as one.

There was also nothing new in the use of publicity and promotional gimmicks as a means of attracting attention to the cause, but the extent to which such efforts were carried between 1914 and 1933 was unprecedented in the annals of metric campaigning. The publicity battle between the metric advocates and the opposing forces developed into a contest to determine which side could secure the approbation of the greatest number of famous men, powerful associations and influential corporations. A separate effort was made to win over public officials—Congressmen, Senators and executive branch leaders. This publicity was gained not only by an extraordinary amount of attention to the campaign in both the popular press and the technical journals, but also by raising funds to finance a large number of special pamphlets, circular letters and even whole books on the subject.

The decisive events of this era, however, continued to take place in the committee rooms of Congress. More legislation was proposed during this period than in any previous campaign, but only twice were major hearings conducted and not once did this issue get attention on the floor of either the House of Representatives or the Senate. Another abnormal feature of the legislative efforts during this period was that no constant pattern was followed in formulating proposals. Unlike earlier eras, no one way of increasing the use of the metric system was preferred over all others. And yet the proposals that were advanced bore no resemblance to those of previous Congresses—education was not a factor and potential Government applications were treated as minor considerations. The one constant characteristic of most of the bills introduced between 1914 and 1933 was the specific exemption of manufacturers from the requirements of the proposed law. The strategy was to soften the opposition, but it didn't work. Because it didn't work, the proposals became more controversial than ever and did not progress very far down the road to enactment.

For the most part, the arguments used by both sides during this period were simply modernized versions of those that had been advanced for decades. The proponents continued to insist that the metric system was superior, that it should be adopted in the interests of international uniformity, that the costs and difficulties involved in adopting it would be surprisingly slight, and that the eventual displacement of all other systems by the metric system was inevitable. Furthermore, it was said, the maintenance and improvement of our foreign trade depended upon metric adoption. The opponents of the system claimed that the U.S. had already achieved greater uniformity and standardization using the customary English system than was enjoyed by any other nation on earth, that the size of our foreign trade was in no way related to our system of weights and measures, and that changing over to the metric system would be confusing, costly, and not productive of corresponding benefits. In addition, the opponents claimed that what appeared to be a popular clamor for metric adoption was really an artificial demand that had been generated by insidious pro-metric propaganda.

For all practical purposes the great metric crusade began in 1916 with the formation of the American Metric Association. Director Stratton of the National Bureau of Standards was one of the original supporters of the group, as were its first president and secretary, Dr. George F. Kunz and Howard Richards, Jr. Sensing the beginning of a revitalized drive for metric adoption, Frederick A. Halsey and Samuel S. Dale, who had figured prominently in the 1902-1907 controversy, established the American Institute of Weights and Measures to provide ready opposition. After a shaky start, the Institute received excellent financial support for its work, and it became a truly effective anti-metric lobby under the guidance of secretary C. C. Stutz.

The temporary acceptance of the metric system for military purposes in World War I gave additional impetus to the postwar metric campaign, as did the drastic increase in U.S. foreign trade. When the World Trade Club was created in 1919, it immediately set out to capitalize on those two situations. This organization, which was financed by a wealthy manufacturer named Albert Herbert and operated by an advertising agency owned by Aubrey Drury, soon began to flood the country with literature urging metric adoption. A Washington representative, W. Mortimer Crocker, was hired to compensate for the fact that the Club was situated in San Francisco and, shortly thereafter, proposed metric legislation began to appear early in each new session of Congress. To increase the chances of favorable action on any of these bills, a massive petitioning campaign was mounted which eventually resulted in more than 100,000 pro-metric postal cards being sent to Washington.

This great surge of metric activity, both for and against the passage of legislation, finally culminated in hearings before the Senate Committee on Manufactures in late 1921 and early 1922. Supporters and opponents alike turned out in large numbers to make their views known to Senator Charles McNary and his colleagues. When the dust had settled, those who were against the proposition had managed to check the metric advance, at least temporarily, and the Senate Committee declined to act on the proposal.

Four years later, in 1926, the House Committee on Coinage, Weights and Measures met to consider the proposition in formal hearings. In the intervening years, the size of the publicity effort had largely tapered off. In its place, the advocates of the metric system had substituted an effort to secure the assistance of individual legislators and official bodies such as the Pan-American Standardization Conference. Nevertheless, the question was still being pursued with a great deal of zeal and persistance by both sides. Once again a great deal of testimony was taken and once again the opponents carried the day. Although several alternative legislative maneuvers were employed in subsequent months, success was not to be achieved by the metric supporters of this era.

Following the 1926 failure, the great metric crusade slowly began to atrophy. Although occasional spurts of activity continued to occur until

1933, none of these represented much more than a half-hearted attempt to revive an issue which nearly everyone admitted was dead.

With the onset of the great depression, the money needed to support a legislative campaign ceased to be available. Nor was there any money to pay for a transition to the metric system, no matter how simple it might prove to be. And so the issue was laid to rest for a quarter of a century, with only minor exceptions. Not until the post-Sputnik years would serious consideration again be given to the question of U.S. adoption of the metric system.

VII. TO BE CONTINUED (1959–1968)

At this juncture in the history of the metric system in the United States, a properly cautious historian would probably review briefly the few noteworthy events that occurred between 1933 and 1959 and then stop. He would note that legislation to authorize a Government study of the question in all its aspects was enacted in 1968 after 10 years of negotiation, but he would not go deeply into that process, rightfully observing that these actions would only be the *beginning* of the next, and perhaps final, chapter and should be left for future historians to interpret.

This account will go somewhat beyond that. It will chronicle some comparatively recent events which, even at this early date, appear to have had some significance. It will trace the development of Public Law 90-472 of August 9, 1968, and it will note some contemporary opinions that were expressed on both sides of the question. The only purpose of doing this, however, will be to bridge the gap between the concerns of earlier metric campaigners and those of the participants in the debate during the 1950's and 1960's. The material in this chapter has been deliberately selected from a wealth of available statements to demonstrate that there is, indeed, a common thread which runs through the history of the metric system from beginning to end. Therefore, it must be stressed that this chapter is *not* intended to reflect a concensus of current opinion on the subject, nor does it represent a comprehensive record of all the activities, events and individual contributions of these years that might prove to be vitally important to future generations. In fact, certain events that are sure to be of major significance—such as the report of the U.S. Metric Study (of which this history forms a part) and the Congress' disposition of it—have yet to occur.

A. THE DOLDRUMS (1933–1958)

After the great metric crusade crumbled in the early 1930's, a quarter of a century elapsed before anything even approaching widespread interest in the question of U.S. policy with respect to the metric system developed again. The reasons for this long period of dormancy are not hard to find.

For one thing, there was the health of the American economy to consider. Even after the corner had been turned on the depression there was not enough money available to warrant the addition of any unnecessary burdens on American industry, such as altering or replacing machinery on a wholesale basis in order to effect a change of measurement systems. There was also the fact that many manufacturers had strongly resisted making the change even when money was comparatively easy to come by.

Another factor in the absence of a metric campaign during these years was the prevailing political mood of the Nation, which was an isolationist one. Even the casual reader of this history will have noticed the perpetual recurrence of a very strong connection between the metric issue and matters pertaining to the international stature and foreign commercial dealings of the United States. Such considerations as intergovernmental arrangements (tariffs and postal exchanges in particular), improved foreign trade, standardization of product and commodity sizes, and international uniformity of weights and measures have generally been the main justifications for urging U.S. adoption of the metric system. There were times, however, when such pleas fell on deaf ears. The 1920's and 1930's were such times. As related by historians Morison and Commager:

> "This isolation which the country had formally embraced in 1920 was not only diplomatic and political, but economic and even moral. Tariff barriers made it increasingly difficult for foreigners to sell or buy from the United States or to pay their war debts. Many leaders dallied with the notion of economic self-sufficiency, refusing to recognize the international spread of American trade and investments or the dependence of American manufactures upon materials imported from abroad. And behind the economic and political isolationism was the vague but pervasive attitude that the United States was morally superior to the nations of the Old World, and that she could better safeguard her moral superiority if she avoided contamination with Old World secret diplomacy, wars, racial hatreds, and decadent cultures [1]."

This very attitude was openly displayed by the opponents of metric adoption throughout the 1920's and 1930's. It can be seen in their steadfast insistence that the U.S. already had a superior systems of weights and measures, that this system had given us more internal uniformity than was possessed by any other single nation, and that the proper use of it had already placed America in a dominant position in world trade. In short, the system we already had was the best one and it was up to others to learn from us.

Since such thoughts were representative of the views of the majority at that time, there was little that metric advocates could do to overcome them.

Because of the depth of which these feelings ran, only one noteworthy event occurred on the weights and measures front prior to the end of World War II. In 1937 a bill "to define certain units and fix the standards . . ." was introduced in Congress.[1] This legislation had been drafted by the National Bureau of Standards and was being sponsored in the House by Representative Andrew L. Somers of New York, the Chairman of the Committee on Coinage, Weights and Measures. It was not directed to securing favorable action with respect to the metric system. Instead, it proposed to legally adopt the *standards* of the metric system that the U.S. possessed while, at the same time, legally adopting the *units* of the English customary system. Under this bill, the English units were to be defined as certain specified fractions of the metric standards. The "inch," for example, would be adopted as the legal unit of length, but it would be defined as 254/10,000 of the meter. Had this bill been enacted, the Congress' authority "to fix the standard of weights and measures" would have been discharged by accepting the metric standards, but the English system would also have been legalized at the same time.

Hearings on this proposal were conducted by the Committee on Coinage, Weights and Measures on August 12, 1937 [2]. The first witness was Dr. Lyman J. Briggs, director of the National Bureau of Standards, who explained why the bill had been requested:

> "It seems strange, 150 years after the founding of this Republic, that legislative action should be necessary to fix the value of the inch and pound with which we are so familiar. Nevertheless, the fact is that we have never had a statute which defines the way in which these units shall be determined [3]."

Aside from Dr. Briggs, those who appeared at the hearings seemed to be a little bewildered as to what effect the bill would have and, as a consequence, did not say much about it at all. Mr. Robert F. Cogswell, representing the American Institute of Weights and Measures, for example, read a statement from Walter Renton Ingalls to the effect that:

> "We have no serious objection to H.R. 7869 as drafted. Perhaps I might say we have no objection at all. However, we experience a certain feeling of regret that we should go ahead without being accompanied by Great Britain [4] . . ."

And Mr. J. T. Johnson, who had succeeded Dr. Kunz as president of the Metric Association, said:

> "Insofar as the present bill counteracts the furtherance of international metric measures, I am opposed to it. On the other hand, if the bill supports the international metric movement, I am for it I

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[1] Eventually, three bills of this type were proposed: H.R. 7869, June 30, 1967 (75th Congress, 1st Session); S. 3609, Jan. 5, 1938 and H.R. 8974, Jan. 14, 1938 (75th Congress, 3d Session).

> am not yet clear whether the bill is in contradiction to the metric movement or not [5] . . ."

Mr. Somers did not think it was and, on August 18, 1937, he sent a report to the House on behalf of the Committee that recommended passage of the bill with only a few minor amendments suggested [6]. Even though no action was taken as a result of this report, it was a significant document for two reasons—it was the first report dealing with the subject that had been released by a Congressional committee since 1902, and it was also to be the last report on the subject submitted by the Committee on Coinage, Weights and Measures.

After this one brief reappearance, the metric issue faded from the Congressional scene for many years. The adverse influences of the depression and the period of isolationism were replaced by obstacles of a different sort during World War II. Unlike the situation during the early years of World War I, when a metric revival had been fostered by the lack of international uniformity and the need to standardize our materiel with that of our allies, the circumstances in World War II were reversed. This time other nations were depending on the United States to provide vitally-needed supplies, and we obliged them under the terms of the Lend-Lease Act. They were, of course, more than happy to receive such assistance regardless of the measurement system which had been used in manufacturing the goods. In addition, most of these supplies were bound for non-metric nations, anyway, particularly Great Britain and the Soviet Union, so that the lack of metrological uniformity was not such a significant problem between 1939 and 1945 as it had been earlier. With industrial production at a wartime peak, no one was entertaining serious thoughts of switching over to the metric system.

Toward the end of the war, however, and immediately following it, there was a resurgence of interest in the idea. Some of this interest was no doubt left over from the 1920's campaign, and the rest of it may have been occasioned by the extent of our involvement in rebuilding the economies of metric-based European nations. But even though plans for a new campaign were being drawn up in 1944 [7], no great outpouring of literature or legislation resulted. Only a few resolutions and memorials from various societies urging metric adoption came out of these efforts.

Even this was serious enough to cause Walter Renton Ingalls, the tenacious president of the American Institute of Weights and Measures, to publish a collection of "standard" anti-metric arguments in 1945 [8]. His book, entitled *Systems of Weights and Measures,* was the last document of any note published under the masthead of the Institute, and even it deserves only passing notice. Its most outstanding characteristics were a lack of originality (and, upon occasion, accuracy) and its concentration on events that were long since over and done with. In fact, Mr. Ingalls aimed most of his attack at imaginary legislation of a type that hadn't been proposed in over 15 years and was refuting a pro-metric case that had died with the World Trade Club.

In the following year, 1946, the House Committee on Coinage, Weights and Measures was quietly abolished by a Legislative Reorganization Act. Its

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coinage functions, which in recent years had been limited to recommending commemorative medals, were transferred to the Committee on Banking and Currency, and its weights and measures duties were taken up, for the time being, by the Committee on Interstate and Foreign Commerce. During the 82-year lifetime of the Committee, a continuing succession of Chairmen and members had worked ardously to accomplish the elusive goal that had been set by the first Chairman, John A. Kasson, in 1864. But the final step needed to complete the metric system reform in the U.S. had never been taken.

Two years later, in 1948, the first full-length pro-metric book since the 1920's was published. The "Twentieth Yearbook of the National Council of Teachers of Mathematics" was given over solely to a discussion of the advantages of the metric system [9]. This occurrence was at least partially due to the fact that the chairman of the Council's yearbook committee (and, therefore, the book's compiler) was Dr. J. T. Johnson, who was also the president of the Metric Association. The book contained a collection of articles dealing with the various aspects of the subject: the concept of the metric system, its technical development and its international growth; its potential advantages for education, science, engineering, manufacturing, and so on; examples of some of the publicity which had been given to the idea of metric adoption; and examples of methods that might be employed in making the change. In spite of the plea, which was repeated throughout the book, that the postwar world offered an ideal opportunity to make the change, no evidence of greatly renewed interest was forthcoming.

In July, 1950, an Act was passed,[2] which redefined the units and established the standards of electrical and photometric measurements in the United States. This was essentially a modernization of the Act defining electrical units which had been in force since 1894. The sole purpose of this revision was to correct technical deficiences in the existing legislation and thus make it possible to achieve a worldwide agreement on electrical units and standards [10]. For this reason, all units were defined in terms of the "centimeter-gram-second," or metric system just as they had been in the original Act. This action, therefore, represented no change in the official status of the metric system in the U.S.

With the passage of this Act significant developments in the field of weights and measures in the United States came to an end for several years. In Great Britain, however, a noteworthy report of the Board of Trade was submitted to Parliament in May 1951 [11]. This became known as the "Hodgson Report," the chairman of the Board's Committee on Weights and Measures Legislation being Edward H. Hodgson. This report dealt generally with the need for a consolidation of the laws on weights and measures, with weighing and measuring equipment, with short weight and measure, and with various aspects of administering and enforcing the laws. It also addressed specifically the question of metric adoption:

"It is . . . hardly correct to talk of the 'imperial system' in quite the same way as one talks of the 'metric system.' The latter forms one

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[2] Public Law 617—81st Congress (July 21, 1950).

compact, closely-defined and universally-recognized system of measurement under the guidance of an international body consisting of representatives of all the countries subscribing to its activities; whereas the imperial system is really a conglomeration of units which have in the past been found convenient for particular types of measurement and which have, over the years, been linked together to form a rough whole. Under the umbrella heading of the imperial system, there are five different systems of weight and three of capacity at present lawful in Great Britain [12].

Bearing all . . . arguments in mind, we have come to the unanimous conclusion that the metric system is, in the broadest sense and in the interests of world uniformity, a 'better' system of weights and measures than the imperial; that a change from imperial to metric for all trade purposes is sooner or later inevitable; that a continuance of the present option to use either the metric or the imperial until the inevitable comes about will cause in the long run more inconvenience than an ordered change within a specified period; and that the long term advantages which would flow from an organised change in the near future would far outweigh the inconveniences of the change itself. We therefore recommend that the Government should straightway take the steps which we outline below with a view to abolishing within a definite period [20 years] all use of the imperial system in Great Britain and to establishing the sole use of the metric system for all trade purposes.

We would, however, make two important provisos. First, any change of this nature should only be done in concert with those countries of North America and the Commonwealth which base their units on the yard and the pound . . . Secondly, the internal convenience of a decimal system could not be adequately realised unless at the same time the coinage was decimalised [13]."

It would take Great Britain 14 years to get around to putting these recommendations in force, but they were implemented eventually, as will be noted later in this chapter.

In the late 1950's a number of actions were taken which signalled the beginning of renewed interest in matters pertaining to the measurement system employed by the United States. In 1957, for example, the U.S. Army issued a regulation establishing the metric linear units as the basis for weapons and related equipment and a committee of the newly Formed Organization of American States recommended adoption of the metric system throughout the Western Hemisphere [14]. Also in 1957, a new era in the history of scientific and technological endeavor was ushered in when the Soviet Union successfully placed the first Sputnik satellite in orbit. That event led to another in the following year which is of significance to the history of the metric system in the U.S. In 1958, the House of Representatives created a standing Committee on Science and Astronautics. Among other things, this Committee was given jurisdiction over the "Bureau of Standards, standardization of weights and measures and the metric system [15]." The new Committee would have occasion to exercise this authority shortly after its establishment. Also, in December, 1958, values for the United States yard and pound were aligned with those of other nations adhering to the customary system.

There had been much discussion over the years, at least since 1920, as to whether our yard and pound were the same as those of Great Britain. The 1958 agreement, which was negotiated by Dr. Allen V. Astin, director of the National Bureau of Standards, and the directors of corresponding institutions in other nations, was announced in the *Federal Register* on July 1, 1959 [16]. The yard was henceforth to be defined as 0.9144 meter and the avoirdupois pound as 0.45359237 kilogram, and these values:

> "[D]esignated as the International Yard and International Pound, respectively, will be used by the National Standards Laboratories of Australia, Canada, New Zealand, South Africa, and United Kingdom; thus there will be brought about international accord on the yard and pound by the English-speaking nations of the world, in precise measurements involving these basic units [17]."

In essence, this announcement was an updated version of the so-called "Mendenhall Order" of 1893, but it's real significance was to be found in the acceptance of these definitions by the other nations listed. Inconceivable as it may seem, this was the first joint action taken by the United States and Great Britain in over 200 years of independent existence to secure uniform values for the units of the customary system of weights and measure to which both nations had so tenaciously adhered. Ironically, this action was taken at a time when both nations were about to renew their investigations of the feasibility and desirability of official action with respect to the metric system.

B. AUTHORIZING A STUDY OF THE ADVANTAGES AND DISADVANTAGES OF INCREASED USE OF THE METRIC SYSTEM (1959–1968)

In late 1958 the British Association for the Advancement of Science launched another investigation into the metric system to attempt to find out what it would cost Great Britain to change and what the long-term benefits of metric adoption would be [18]. Early in 1959 the American Association for the Advancement of Science followed suit by establishing a committee to consider the problems involved in a change after approving in principle the general adoption of the system [19]. On May 1, 1959, the question of U.S. use of the metric system was given new life when Lewis L. Strauss, who was then awaiting Senate confirmation of his appointment as Secretary of

Commerce,[3] addressed the spring meeting of the American Physical Society in Washington, D.C.:

"I should like to direct your attention to a special problem of the Department. One which has great scientific and technological significance for our economy and our culture. It is not by any means a new problem but the vast expansion of science and technology in the past 10 years has brought it once again to official attention.

I am speaking of our system of measurement. One of the first letters I received after my appointment as Secretary of Commerce dealt with this problem. It was a letter from one of your fellow scientists and a good friend. He urged that I could perform a worthy national service if I would exercise the powers which he assumed were vested in me and by decree abolish the English measurement system and institute the metric system in the United States. The idea of change is meritorious but the proposed means of achieving it is [sic.] impractical.

I have long been convinced that ultimately the United States must shift to the metric system. Outside of our Anglo-Saxon culture, practically every nation has made this shift during the past 150 years or so. Every country found it possible to adopt the metric system—just as in earlier times we all shifted from the Ptolemaic to the Copernican system of navigation. No one ever regretted the temporary inconvenience of such switches. Due to our delay in taking action and due to the complexity of our industrial system, this change will be more difficult for the United States than for other countries, but when achieved it will also be more useful.

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In brief, a dynamic country like ours where new commodities are adopted incessantly and where inventories are replaced periodically has the capability of executing a change in its measurement system. Our capability is not in question. What we need is a procedure by means of which the change can be carried out most expeditiously with the least cost, the least confusion and the least opposition.

. . . . Accordingly, I propose to request the Director of the Bureau of Standards to establish an advanced planning group to assemble all available documentation and to identify possible courses of action [20]."

On the surface, this address would seem to have been just the latest in a long series of pleas for adoption of the metric system made by high Government officials to scientific gatherings. And perhaps it would have been a routine matter if Admiral Strauss had not been such a controversial figure at

[3] Which was never granted.

that time, but his public utterances were generally headline material. As the Washington, D.C., *Evening Star* put it the following day:

"The year's most controversial after-dinner speaker talked last night on the year's least controversial topic—the metric system.

But even on that theme Secretary of Commerce Strauss did not find himself unanimously supported by his audience . . . .

Mr. Strauss' pitch for the adoption of the meter in place of the yard, the kilogram in place of the pound and the liter in place of the gallon apparently was designed as the oil to be poured on troubled waters. His appearance had become a cause celebre in the meeting, just concluded, of the physical society.

. . . . [B]ut a cursory survey after his speech indicated that it fell on unimpressed, if not deaf, ears. Physicists universally use the centimeter-gram-second system, and engineers use the kilogram-meter-second [sic] system [21]."

Irrespective of the controversy surrounding Secretary Strauss, he advanced some convincing reasons for reopening the investigation into the official standing of the metric system in the U.S. First of all, there were the simultaneous inquiries being conducted by the British and American Associations for the Advancement of Science. Secondly, both India and Japan were in the process of enforcing compulsory metric laws that had long been on the statute books but never carried out. Thirdly, there was the fact that certain American industries, notably chemicals, pharmaceuticals, and electronics, were already doing most of their business in terms of the metric system. There was also the need to make our military equipment compatible with that used by our NATO allies and the fact that "the uniformity of measurement systems between Russia and most of the world, including Western Europe, is an enormous advantage to the Soviets and a handicap to us [22]." Finally, the Secretary asserted that action was called for because American foreign trade was beginning to be hurt by our non-use of the metric system in manufacturing and labeling products.

These concerns and the Secretary's proposal to have a study initiated by the National Bureau of Standards were formalized in legislation introduced, on May 27, 1959 by Rep. Overton Brooks of Louisiana,[4] providing that:

The National Bureau of Standards shall conduct a program of investigation, research, and survey to determine the practicablity of the adoption by the United States of the metric system of weights and measures.

This bill further specified the activities which the Bureau was to be authorized to undertake in conducting the program, and set a time limit of one year for the completion of the study.

The detailed objectives of making such a study were not included in Mr. Brooks' proposal, but they were laid out in a bill introduced by Senator

[4] H.R. 7401 (86th Congress, 1st Session). Mr. Brooks was then chairman of the Committee on Science and Astronautics.

Richard Neuberger on July 22, 1959.[5] This legislation, which assigned the responsibility for the program to the Secretary of Commerce and extended to 3 years the time limit for the investigation, called for investigations, research, surveys, consultation with government agencies, private organizations and foreign governments in order to determine and analyze:

1. Standards and comparative advantages of weights and measures presently used in science, engineering, manufacturing, commerce and education;
2. Benefits which the United States might derive from general adoption of the metric system or application of such a system in specific fields, including consideration of the effect such a change would have on United States international relations, world trade, and military activities; and
3. Practical difficulties which might be involved in achieving adoption of the metric system for use generally or in specific fields in the U.S.

One week later, on July 29, 1959, a third alternative was offered by Representative James G. Fulton of Pennsylvania.[6] The concurrent resolution which he submitted read:

Whereas substantially all of the nations of the world except the United States have adopted the metric system of weights and measures; and

Whereas the metric system exclusively is used in scientific measurement; and

Whereas the United States, as the leader of the free world in scientific effort should join the other nations in adopting the standardized metric system in all fields of endeavor; and

Whereas our educational system must be geared to the achievement of this objective and make its vital contribution through the teaching of the metric system of weights and measures at all levels: *Therefore be it*

Resolved by the House of Representatives (the Senate concurring), That it is the sense of the Congress that the President of the United States should take the appropriate steps, with the counsel of the Nation's leading educators and scientists, to effect the adoption of the metric system of weights and measures as the Nation's official system of measurement in all appropriate fields of endeavor, and direct that all departments and agencies of the United States (particularly those having functions related to education or schools) foster and promote the understanding and use of such system by all the people of the United States.

Although neither Chamber took immediate action with respect to these three proposals, the legislative pattern for the next decade had been

[5] S. 2420 (86th Congress, 1st Session).

[6] H. Con. Res. 364 (86th Congress, 1st Session).

established. Both options—the one to study the proposition and the one to begin formal adoption immediately—would be repeated in successive Congress until a comprehensive study was authorized in 1968. Before this occured, however, several hearings were held to consider the matter and a number of important changes were made in the legislation proposed.

In the following year, 1960, two noteworthy events occurred. In May, the British Assocation for the Advancement of Science, in conjunction with the Association of British Chambers of Commerce, issued its report. Entitled *Decimal Coinage and the Metric System—Should Britain Change?,* it was an essentially negative report insofar as its recommendations with respect to the metric system were concerned [23]. Instead of metric adoption, an improvement of the customary system was urged. This recommendation was based on a number of findings which had become very familiar over the years, including the opinions that [24]:

1. "Little use is made today of the metric system in the U.K. except for scientific and laboratory purposes . . . ."
2. "There is little sign in the U.K. of any significant trend toward increased usage except in . . . export to metric countries."
3. "There is no strong feeling in industry and commerce that we are being adversely affected . . . by retention of the Imperial system . . ."
4. "There is a majority opinion that the U.K. should in any case keep in line with the Commonwealth and with the United States of America."
5. "With regard to cost factors, the general picture is clear that there would be very heavy transitional costs in some spheres, particularly engineering, but the financial benefits seem much harder to assess."

On the subject of decimal coinage, the joint committee announced that strong sentiment for the adoption of such a system existed, but the members had apparently not been able to decide what specific action to suggest. Instead, they simply observed that this was the Government's decision to make and recommended that the Government make one soon.

In October 1960, the meter bar which had served as the international standard of length for over 70 years was abandoned. In its place, the 11th General Conference on Weights and Measures substituted a wavelength of light—1,650,763.73 wavelengths of the orange-red line produced by krypton 86 being defined as 1 meter [25]. This new definition represented a return to the original concept underlying the metric system—an immutable standard found in nature. It also had the advantage of being reproducible with great accuracy by any well-equipped laboratory, an attribute not possessed by the meter as defined in 1795. At that time, also, the name of the metric system was formally changed to the *Système International d'Unités*, or "SI," in recognition of the widespread acceptance of the system and to avoid confusion stemming from certain uses of measurement units in the world's technical literature.

In the first session of the 87th Congress, in 1961, several more bills were introduced. Rep. James Roosevelt of California introduced a bill identical to that of Senator Neuberger's earlier one, Rep. George Miller of California proposed legislation identical to that advanced by Mr. Brooks in the previous congress, and Rep. Fulton reintroduced his concurrent resolution.[7] On the Senate side, Mrs. Maurine Neuberger introduced a proposal similar to that of Mr. Neuberger's,[8] except that it would also have required an investigation to be made into the benefits to consumers of metric adoption.

In June and July, 1961, a Subcommittee of the Committee on Science and Astronautics, chaired by Mr. Miller, conducted hearings on the two study bills [26]. A total of 9 witnesses were heard from, all of whom favored a study of the subject. These included Congressman Roosevelt; Dr. A. V. Astin, Director of the National Bureau of Standards; Colonel Walter Woodward of the U.S. Air Force; Colonel G. P. Grant of the U.S. Army; Floyd W. Hough, representing the American Geophysical Union; and Drs. J. T. Johnson and Robert P. Fischelis representing the Metric Association, Inc.

Following the hearings, the full Committee amended Mr. Miller's bill to allow 3 years for the study and to require the submission of annual progress reports. A favorable report was then unanimously agreed to and Mr. Miller submitted it to the House on July 25, 1961 [28]. The report noted that:

> "While there is no doubt that the subject matter of conversion to the metric system is controversial, the concensus of opinion indicates that the proposed study would be a substantial step toward settling the controversy, and in this way the public generally, as well as industry, educational, scientific, and government agencies could have a part in contributing to the study. It is the feeling of the committee that it is only through education that any change may be forthcoming and that such an educational program would receive the desired impetus through the study bill under consideration [29]."

The report also estimated that the cost for the full 3-year study, based upon a preliminary plan devised by a Department of Commerce task force, would not exceed $500,000.

On August 7, September 6, and September 18, 1961, the Miller bill came before the House of Representatives on the Consent Calendar. On each occasion the measure was passed over without prejudice when Representative H. R. Gross of Iowa questioned the necessity of making a costly study of the subject. As he said, "I am not opposed to the establishment of the metric system as the standard of weights and measures for the country, but I know of no reason why we should spend half a million dollars for a study [30]." Several subsequent attempts to secure passage of the bill by unanimous consent also failed, and in 1962 the legislation was removed from the Consent Calendar.

Even though these events delayed passage of the bill, the fact that Con-

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[7] H.R. 269, Jan. 3, 1961 (Mr. Roosevelt); H.R. 2049, Jan. 6, 1961 (Mr. Miller); and H. Con. Res. 44, Jan. 6, 1961 (Mr. Fulton).

[8] S. 2030, June 7, 1961.

gress was giving serious attention to the question had the effect of arousing new interest in it in the press. An increasing number of newspapers began to print editorials favoring metric adoption and the nation's technical journals devoted a great deal of space to exploring both sides of the issue. As in earlier decades, the mechanical engineering profession was the one that was most interested in the outcome of the debate. In the July 1962, issue of *Mechanical Engineering,* for instance, there were four articles dealing with various phases of the question. The first, written by Jens E. Kjemtrup, favored immediate all-out conversion because of the long-range benefits that would accrue to the U.S. Seven classes of benefits were listed:

"1. American and overseas engineers could communicate much more freely . . .
2. The export-import trade in technical goods will benefit . . .
3. American consulting engineering companies will, if the old system is maintained, find their services less and less in demand because customers will want to avoid the confusion originating from American design drawings interpreted by overseas contractors.
4. There is an urgent need for international technical standards which . . . would promote the flow of goods from country to country . . . [U]niversal acceptance of the metric units would be a necessary preparation for work of this sort.
5. The units of the SI [Système International, or metric] system are well defined and easily reproducible with high accuracy. This is a feature of no small importance in the fields of precision engineering products, instruments and machine tools.
6. The American engineer and scientist will 'speak the same language' . . .
7. Engineering calculations are simplified [31]."

The second article, authored by R. P. Trowbridge of General Motors, favored a less comprehensive approach to the problem:

"Where economic and technological advantage is to be gained by conversion to the metric system, those elements of U.S. industry, science and engineering which would benefit by such conversion should, by all means, convert. They should convert their own literature, own equipment, own products, etc., and develop their own sources. However, in U.S. industries where the technological advantages are small compared to the long-term economic loss, conversion to the metric system would impose an unwarranted burden [32]."

The third article in this issue of *Mechanical Engineering* contained W. G. Waltermire's proposal for the development of a decimalized inch system, and the last article put forth a seven-part transition program devised by Carl F. Kayan of Columbia University [33]. Similar discussions of various phases of the metric question were published in such magazines as *Product Engineering, News Front, The Tool and Manufacturing Engineer,* and *Science* [34]. Also, in July 1962, the British Standards Institution issued a statement favorable to metric adoption within a defined time period and containing a tentative 20-year program plan for changing over to the system [35]. By the end of 1962, in short, the extent of general interest in the question of metric usage was greater than it had been in over 30 years in both the U.S. and Great Britain.

Consequently, with the convening of the 88th Congress in 1963, legislation to study the proposition was again introduced in both the House of Representatives and the Senate. On the House side, bills were filed by Mr. Miller, Mr. Roosevelt and Representative McClory of Illinois.[9] In the Senate, a measure was proposed by Senator Claiborne Pell of Rhode Island.[10] All of these bills were very similar to Mr. Miller's bill of the previous Congress, as amended, and called for a 3-year investigation by the National Bureau of Standards.

Hearings were again held, this time before the Senate Committee on Commerce, in January, 1964 [36]. At that time the bill's sponsor, Senator Pell, personally explained the need for such legislation to the Committee:

"In my travels through the world both in the Foreign Service and in other capacities, I have been constantly impressed with the ease with which people conversant with the metric system could handle weights and measures. It became apparent as I went from country to country that the metric system was perhaps the closest thing the world has to an international language. It facilitates commerce of every kind, and it obviously is simple to learn. Yet, as more countries came to adopt the metric system, the most striking paradox was the position of the English-speaking nations with their cumbersome and confusing systems of inches and pounds, gallons and tons.

My interest in seeing this country brought up to date, then, prompted the introduction of my bill .... S. 1278 does not call for conversion, it calls for a study of the feasibility of converting. It takes the approach which I would hope is that of the reasonable man—in solving important problems let us gather all the facts before making a decision [37]."

Director Astin of the National Bureau of Standards also supported the bill, noting that the decision to change or not to change should be made not only on the basis of dollar costs and benefits, but also on intangible factors such as the impact of our non-use of the metric system on the role of the U.S. as a world leader. He further suggested that it might be profitable to study the experience of American industries that had voluntarily switched to the metric system (particularly the pharmaceutical industry) and to investigate the experience of countries, such as Japan and India, that were now in the process of implementing a changeover. Finally, Dr. Astin estimated that the scope and complexity of the study called for would require appropriations of

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[9] H.R. 18 (Mr. Miller), Jan. 9, 1963; H.R. 403 (Mr. Roosevelt), Jan. 9, 1963 (88th Congress, 1st Session) and H.R. 10089 (Mr. McClory), Feb. 25, 1964 (88th Congress, 2d Session).

[10] S. 1278, April 4, 1963 (88th Congress, 1st Session).

$750,000 the first year, with lesser amounts being needed in the following two years.

Dr. Robert P. Fischelis, president of the Metric Association, Inc., outlined his organization's long standing interest in seeing the metric system of weights and measures adopted in the U.S. and expressed the group's support of the bill. The Association's reasons were slightly different from those of Senator Pell and Dr. Astin, however:

"We are interested in an exploration of the controversial features concerned with the effort to adopt the metric system because we feel that, once all the pros and cons have been explored and evaluated, there will be little or no resistance to the adoption of the metric system. In order that this exploration may be unbiased, factual and clear to the American people, it should be conducted under auspices which are respected and which will be accepted as authentic.

It is our feeling that S. 1278 provides for such an unbiased and authoritative study which can be accepted by the Congress of the United States as a basis for action in this area [38]."

The final witness to appear before the Committee was Assistant Secretary of the Air Force Alexander H. Flax, who presented the views of the Department of Defense on the proposal. Noting that earlier studies by the individual services had produced varying and inconclusive results in this area, Mr. Flax fully supported the idea of an in-depth investigation and promised the Defense Department's full cooperation. "It is clear," he said, "that the adoption of the metric system would have such an extensive effect upon the military services of the United States that it would be impractical for the military services to remain on the English system while the country changed to the metric system, or for the military services to change measurement systems to a substantial degree while the country adheres to the English system [39]."

No Congressional decision resulted from these deliberations, but the issue continued to occupy a large volume of space in both popular and technical literature. Consequently, in the following year, 1965, a great deal of attention was given to the question of metric usage both inside and outside of Congress.

To begin with, several more metric study bills were introduced early in the 89th Congress. House bills identical to or very similar to those of the preceding Congresses were introduced by Representatives McClory, Roosevelt, Miller and Quie of Minnesota, and Mr. Fulton re-introduced his proposal to dispose of the issue by means of a concurrent resolution.[11] Senator Pell also sponsored legislation in the 89th Congress.[12] His bill was somewhat different from those pending in the House in that it directed the

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[11] H.R. 38 (Mr. McClory), Jan. 4, 1965; H.R. 1154 (Mr. Roosevelt), Jan. 4, 1965; H.R. 2626 (Mr. Miller), Jan. 13, 1965; H.R. 8957 (Mr. Quie), June 10, 1965; H. Con. Res. 458 (Mr. Fulton); [89th Congress, 1st Session].

[12] S. 774, Jan. 27, 1965 (89th Congress, 1st Session).

Department of Commerce to appraise "the desirability, practicability *and cost* of a *general conversion* to use of the metric system," was more comprehensive in laying out the areas to be studied, and specified that a maximum amount of $2,500,000 might be appropriated to conduct the program.

Before either Chamber had acted on any of these bills, however, a significant and long awaited event took place. As reported in the *New York Times* on May 25, 1965:

"The British Government announced today plans for the conversion of weights and measures to the metric system over the next 10 years.

The object is to mesh British standards with those of Continental Europe, the biggest market for British exports . . .

Douglas Jay, president of the Board of Trade, said in the House of Commons that metric units would be adopted 'sector by sector' until they become the primary system of weights and measures for the country as a whole . . . .

The announcement means that the United States will be left as the only major power using nonmetric units . . . .

There is no immediate question of legislation. Eventually, though, regulations that now require the standard loaf of bread to be 14 ounces and milk to be sold in half pints will have to be changed. There are exceptions to the general rule allowing use of two systems of measures.

British industry is solidly behind the changeover and in fact was the driving force behind today's declaration [40]."

In the U.S., meanwhile, active discussion and debate on the matter continued. At its December, 1964 Winter Annual Meeting, for instance, the American Society of Mechanical Engineers adopted the following resolution:

"The American Society of Mechanical Engineers, in the interest of national economy and industrial efficiency, advocates the continued use of the existing American, British and Canadian sizes, modules, designs, and ratings. Further, the Society is of the opinion that legislative action directed to an alternate system of dimensional standards, such as the metric, will be at this time confusing and disturbing to the productive capacity of the United States and is not, therefore, in the best of public interest [41].

There were other bodies, however, who were equally interested in investigating the matter further. One of these was the U.S. Chamber of Commerce, which adopted a resolution in April, 1965, favoring a study of the feasibility of U.S. adoption of the metric system [42].

On July 14, 1965, the Senate Committee on Commerce met to hear the arguments for and against Senator Pell's bill [43]. Supporting the bill were several witnesses, including Senator Pell; Leroy M. Alexander, chairman of the Industrial Fasteners Institute; Irving Lipkowitz, representing the U.S. Chamber of Commerce; and J. Herbert Hollomon, Assistant Secretary of

Commerce for Science and Technology. Robert M. Byrne, representing the screw, nut, and rivet manufacturers, appeared in opposition to the bill on the grounds that "no amount of study can eliminate the fact of burdensome economic cost of a long period of changeover." Mr. Bryne told the Committee that if a study were authorized, however, the industries he represented would cooperate fully in the conduct of it. On his part, Dr. Hollomon assured the Committee that the Department of Commerce would seek "the best possible advice from representatives from American commerce, industry, engineering, science, labor, consumers, and government" through broadly based advisory committees. He also identified five possible solutions to the problem which might emerge from such a study as feasible courses of action:

1. General adoption of the metric system by legislation.
2. Voluntary extension of metric usage on an industry-by-industry basis.
3. Regulated partial conversion, segment by segment in identified areas over an extended period, with plans for handling the resulting coexistence of mixed systems.
4. Solutions other than adoption of the metric system, to mitigate the crucial problems without forced conversion by law.
5. A system of financial incentives to those who voluntarily convert.

A study was needed, in Dr. Hollomon's opinion, to enable a choice of the proper alternative to be made on the basis of all of the relevant information.

In early August, before the Senate Committee had issued its report, additional hearings were held before the House Committee on Science and Astronautics to consider Mr. Miller's bill [44]. Once again the testimony presented was strongly in favor of the legislation proposed. Among those who either appeared before the Committee or submitted statements supporting a study were Representatives McClory, Quie, and Roosevelt; Dr. Hollomon; Dr. Douglas V. Frost of Abbott Laboratories; Mr. George P. Larrick, Commissioner of the Food and Drug Administration; Dr. Donald F. Hornig, Director of the Office of Science and Technology and the President's Science Advisor; Dr. Thomas J. Macek, council member of the American Pharmaceutical Association; Dr. Alfred J. Eggers of the National Aeronautics and Space Administration; Dr. Astin of the National Bureau of Standards; and Mr. Alexander of the Industrial Fasteners Institute. Mr. Byrne also appeared before the House Committee to present the objections of the screw, nut, and rivet manufacturers.

As a result of these hearings, Chairman Miller submitted a Committee Report with an amended bill on August 24, 1965 [45]. This report went deeply into the need for a comprehensive study, listing such major considerations as:

1. The possibility that U.S. failure to use the metric system was hampering our ability to compete successfully with foreign companies in many product lines.
2. The fact that some U.S. industries had already accepted the metric system and that others were preparing to do so in the near future.

3. The fact that "Those countries which have not at this date changed over to the metric system are few and their ranks are growing thinner [46]." The action of Great Britain in particular was singled out as indicative of the need for some corresponding action on the part of the U.S.
4. The need to resolve "the innumerable, widespread, commercial, industrial, educational, economic, and procedural problems" involved in the question of metric usage before proceeding with any change [47].

Mr. Fulton expressed a different view:

> "Time is of the essence for the United States to maintain our leadership in world trade, science, and development and at home in our domestic economy. It is necessary that we immediately announce the policy of the adoption of the metric system.
>
> Our educational system must gear itself to the objective of adoption of the metric system by teaching the system at all levels . . .
>
> I am convinced that the ultimate success of the adoption of the metric system will depend on the young people now in our schools . . .
>
> We need not delay longer . . .

The United States will rapidly be isolated by other industrial trading nations and will lose our U.S. leadership in world trade, scientific research and development. We must begin immediately to lay an adequately broad base for the changeover with ease, not to postpone this essential change for a total of 15 years with further studies. I call for prompt action on the metric system changeover [48]."

But the majority of the Committee had agreed to recommend a revised study bill.[13] Among the important changes included in this legislation was a new statement of the objective of the study which avoided references to "adoption of" or "conversion to" the metric system. Instead, the study was to "determine the impact of increasing worldwide use of the metric system on the United States, to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States." The new bill also specified that "representatives of United States industry, science, engineering, labor and their associations" were to be consulted in the planning and execution of the study. After the Committee had submitted this bill to the House, it was sent to the Rules Committee for further action.

On September 9, 1965, the bill was taken up by the Rules Committee. What happened at that meeting was reported the following day in the *New York Times:*

"The House Rules Committee, headed by 82-year-old Representative Howard W. Smith, Democrat of Virginia, buried today a bill for a study of conversion to the metric system.

[13] H.R. 10329, Aug. 9, 1965 (89th Congress, 1st Session).

Representative George P. Miller, Democrat of California, chairman of the House Committee on Science and Astronautics, argued for his bill . . .

'We'll be one island, isolated, using a system that has little rhyme or reason,' Mr. Miller said . . .

Mr. Smith, peering from under his shaggy eyebrows, told Mr. Miller: 'I got my education in a one-room red school house. We took our degrees in the three R's. Just to make an honest confession, I don't know what the metric system is [49].' "

Despite attempts by Mr. Miller and Mr. Fulton to explain the system to Representative Smith, the chairman of the Rules Committee remained unconvinced and the bill was not sent on to the House for action.

But this had no effect on the Senate's actions. On September 16, 1965, Mrs. Neuberger submitted a Report from the Committee on Commerce recommending passage of Senator Pell's bill, *S. 774* [50]. This report also pointed to the growing use of the metric system throughout the world, the possible impact on U.S. foreign trade, and the lack of agreement as to whether the advantages of using the system outweighed the disadvantages of changing over to it as the main reasons why such a study would be timely and desirable. Changes in the wording of the bill were also suggested that were similar to those which had been made by the House Committee. The major difference was that the Senate bill directed more attention to the international trade and commerce aspects of the problem than its House counterpart, and authorized only $500,000 for the first year of the study (the House bill had authorized $2,500,000 for all years).

Four days later, on September 20, 1965, the Senate passed *S. 774* by unanimous consent [51]. Senator Pell took the occasion to remark:

"Mr. President, the passage of S. 774, today, is the metric equivalent of a milestone in the field of weights and measures. We are putting our best 'foot' forward in an attempt to leap from the confusion of the past to the clarity of the future . . .

I hope that soon we will be able to proceed, conduct a comprehensive study in depth, . . . and make necessary decisions on fact rather than fearful fancy [52]."

In the next session of Congress, the House Committee on Science and Astronautics again tried to bring such action about by considering and reporting on *S. 774* [53]. Once more, however, the bill expired without reaching the floor of the House.

In the 90th Congress, beginning in 1967, the efforts to secure the passage of a metric study bill were renewed by sponsors in both Houses. In the Senate, Mr. Pell introduced a bill very similar to the one which had been passed in the previous Congress.[14] In the House, identical or similar proposals were filed by Congressmen Miller, Ottinger, Quie and Edwards, and a concurrent resolution providing for immediate steps toward metric

[14] S. 441, Jan. 17, 1967 (90th Congress, 1st Session).

adoption was proposed by Representative Fulton.[15] The House Committee on Science and Astronautics lost no time in issuing a favorable report on Mr. Miller's proposal, *H.R. 3136* [54]. Once again, however, the metric study bill failed to reach the floor for debate and decision.

On August 29, 1967, Senator Robert P. Griffin of Michigan introduced a new bill,[16] to authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use." Unlike most earlier bills, which had been limited primarily to calling for an investigation of the desirability and practicability of increasing U.S. use of the metric system, Senator Griffin's bill asked that the study also include consideration of

> "the extent to which the United States should retain and promote international use of the system of weights and measures, and various standards used in connection therewith, currently in use in this country."

In other words, in areas where it would be cheaper, more practical and more desirable for the U.S. to retain industrial and engineering standards based on the customary system, the study was to contain explicit recommendations to that effect. It was also to suggest how, in such instances, international acceptance of such standards might be secured in order for the world to achieve uniformity in weights and measures usage. The subsequent sections of Senator Griffin's bill, which dealt with the common concerns of international trade, military affairs, education, engineering, manufacturing, and so on, were changed to be consistent with this new emphasis. For example, in the sub-section of the bill dealing with international relations, the wording was changed to read:

> [the Secretary shall] investigate and appraise the advantages and disadvantages to the United States in international trade and commerce, and in military and other areas of international relations, of the increased use of an *internationally standardized* system of weights and measures.

On November 15, 1967, the Senate Committee on Commerce held hearings on both Senator Pell's and Senator Griffin's bills [55]. Department of Commerce witnesses, including Assistant Secretary John F. Kincaid and NBS Director A. V. Astin, preferred the language of Senator Pell's bill to that of Senator Griffin's. As Dr. Kincaid put it:

> "We consider it totally unrealistic to contemplate reversal of the worldwide trend towards metric units to achieve international acceptance of U.S. measurement units.

[15] H.R. 3136 (Mr. Miller) Jan. 19, 1967; H.R. 5469 (Mr. Ottinger) Feb. 15, 1967; H.R. 6598 (Mr. Edwards) Mar. 6, 1967; H. Con. Res. 218 (Mr. Fulton) Feb. 20, 1967; (90th Congress, 1st Session).

[16] S. 2356.

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On the other hand, we are in full agreement with the suggestion . . . that every consideration be given to retaining and promoting international acceptance of the product and engineering standards currently used in this country. Many such standards might be retained irrespective of the measurement units in which they are expressed [56]."

Industry representatives, on the other hand, including Richard B. Belford, technical director of the Industrial Fasteners Institute; J. D. Graham, of the International Harvester Company; and Harold Byron Smith, Jr. vice president of operations for the Illinois Tool Works, Inc. seemed to favor the provisions of Senator Griffin's bill. The reason why this was so was aptly stated by Mr. Smith:

"Our fastener people . . . could point out to you that, for them, conversion would present an even greater problem—for in some areas of American manufacturing industry, our technology and degree of standardization is so superior to that used elsewhere in the world, that there is, in fact, no comparable or universally accepted metric standard to which we could convert, if we wanted to [57]."

Of the more than 30 individual, organizational or corporate views presented at these hearings, however, none were opposed to the idea of making a study to determine the facts.

After these hearings, the process of arriving at a bill that would be mutually acceptable to both the House and the Senate began. On April 30, 1968, a great step forward was taken in that direction when Representative Sisk reported a resolution from the Committee on Rules,[17] providing for 2 hours of debate on Mr. Miller's bill, *H.R. 3136* [58]. On June 24, 1968, the resolution of the Rules Committee was called up for discussion in the House of Representatives [59]. After some spirited debate concerning the need to spend scarce funds on making a study, the urgency of making a study, and the desirability of opening up this area of investigation at all, the resolution was agreed to and 2 hours of debate were held that same day [60].

The main speakers were Chairman Miller and Representative Fulton. Mr. Miller outlined the recent history of proposed metric study bills, emphasizing the purpose of the pending legislation:

"Before going further, let me make it crystal clear that this legislation does nothing drastic, does not call for any monumental changes in your way of life; does not call for immediate conversion; it merely requires a study to be conducted by the Secretary of Commerce to determine the impact that increased use of the metric system of weights and measures is having on American life [61]."

Mr. Miller went on from there to review the need for a thorough investiga-

[17] H. Res. 1148 (90th Congress, 2d Session).

tion. He pointed out that only 4 countries out of 106 had not officially established the metric system—New Zealand, Australia, Canada and the United States. He reviewed earlier actions that had had a significant impact on the official standing of the metric system in the U.S.—the Act of 1866, the Treaty of the Meter, and so on. Mr. Miller then noted that many industries were partially using the metric system already, but that others were uncertain as to what action, if any, should be taken. In conclusion, he said that:

"The increasing use of the metric system measurements in both the United States and abroad is likely to pose very serious problems for the economy of this country both in international development and in its relation to the economy of other nations . . . However, there has been a general lack of factual information needed both to guide Government and private business sectors of this country concerning the increase in the metric system. Therefore, the full broad and comprehensive study called for by this bill should be expedited [62]."

Mr. Fulton of Pennsylvania then rose to support the bill: "[T]his bill for a study on the adoption of the metric system should be passed. We are moving into a new scientific age that amazes everyone of us. . . . [W]e can see that ours is a different age, requiring extraordinarily precise measurements.

People who say that our present standard is good enough the way it is are very well intentioned. The question is, though, shall we take the next step in this country and go along with the other countries of the world by moving into the metric system [63]?"

Others supporting the measure during the debate included Representatives Roush of Indiana, Hechler of West Virginia, Ottinger of New York, McClory of Illinois, Rumsfeld of Illinois, Ichord of Missouri, and Gonzalez of Texas. In his speech, Mr. Roush addressed attention to what has been, over the years, one of the most persistent aspects of the debate on metric adoption in the U.S.—the lighter side of the question:

"I [have] found that there are some who complain that such a change would radically change our language; would mar much of our most revered literature.

Individuals have lamented that if we changed from our present system of weights and measures that we would have to abandon Shakespeare's 'Full fathom five thy father lies' . . . as well as the immortal Tennyson's 'Charge of the Light Brigade' in which the 'six hundred' rode 'Half a league, half a league, half a league onward' in the valley of death. Nor could we anymore quote those impressive lines of Robert Frost when he noted that he had 'promises to keep and miles to go before I sleep'.

However, I do believe that we would find new and different measurement systems adaptable to poetic phraseology. One comes to mind at this moment, composed anonymously concerning a famous Smithsonian Institution scientist. It goes as follows:

Simon Langley invented the bolometer
Which is really a kind of thermometer
That can measure the heat from a polar bear's seat
At a distance of half a kilometer.

And even Madison Avenue has adjusted to the infinite possibilities of a different measurement system with their ad concerning the 'silly millimeter longer [64].' "

Returning to the serious side of the issue, a number of amendments to the metric study bill were offered and accepted after the general debate had been concluded. Added to the bill were provisions similar to those favored by Senator Griffin to require investigation of the possibility of retaining certain U.S. engineering standards and submission of recommendations for meeting the difficulties and costs involved in any change of measurement systems. In addition, Mr. Fulton secured approval of an amendment requiring that the first year's funds for the program (not to exceed $500,000) be taken from money previously appropriated to the Department of Commerce.

Following the process of amending the bill, a vote was taken and, by a margin of 269 to 42, the legislation was passed by the House [65]. On August 9, 1968, the U.S. Senate passed the same bill. On August 14, it was signed into law by President Lyndon B. Johnson.

As finally enacted, Public Law 90-472,[18] provided for:

"A program of investigation, research, and survey to determine the impact of increasing use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting by international use of dimensional and other engineering standards based on the customary measurement units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States."

The law also provided Congressional guidance to the Department of Commerce as to the specific areas to be investigated and the organizations to be consulted in performing the study. A 3-year period was allowed for conducting the investigation, at the end of which time the Secretary of Commerce was required to submit "a full and complete report of the findings made under the program authorized by this Act, together with such recommendations as he considers to be appropriate and in the best interests of the United States."

C. CONCLUSION

In nearly two centuries of debate on the matter of fixing a standard for U.S. weights and measures, many important investigations have been

[18] 82 Stat. 693.

made—those of Thomas Jefferson and John Quincy Adams in the early days, and those of such groups as the National Academy of Sciences, the University Convocation of the State of New York, the Franklin Institute, the American Society of Mechanical Engineers, the National Industrial Conference Board, and similar groups in Great Britain in later years. A major difference between these earlier studies and the present U.S. Metric Study is that none of the previous ones was attended by so much discussion and earnest consideration beforehand of the overall objectives which such a study should meet and of the many factors involved in reaching a satisfactory conclusion on the issue. Nor have previous studies provided for such broad participation from all segments of society as is required under Public Law 90-472. Irrespective of the eventual outcome of the present study, then, the question of U.S. use of the metric system will have received a more thorough discussion in the years since 1959 than ever before in our history, and more people will have been involved in the eventual decision than at any other time. For this reason, if for no other, future historians will doubtless record these years as another major period in the history of the metric system in the United States.

VIII. SUMMING UP

Many eminent individuals, prestigious institutions and powerful governments have urged upon the world the advantages to be gained by securing a single system of weights and measures to which all nations might repair. Although the desirability of achieving this goal has seldom been challenged, practical considerations have made the successful attainment of it an elusive proposition—international opportunities have given way to national interests, the fear of unknown political and psychological consequences that might result from initiating such a pervasive social reform have forestalled concerted action, questions concerning the extent to which scientific superiority should prevail over established commercial customs and technological practices have gone unanswered, and potential long-range economic benefits have been balanced against short-term economic expediency. In spite of such problems, however, one system of weights and measures—the metric system—has steadily gained acceptance among the nations of the world until it stands today on the verge of becoming the first truly universal system of weights and measures. One of the major obstacles to the final attainment of that long sought status has been the fact that the United States has repeatedly declined to take action officially adopting the metric system.

The creation of the metric system by France and the beginning of serious deliberations in the United States with regard to fixing a standard of weights and measures occurred in the same year—1790. Since then, the question of whether the United States should accede to the worldwide trend toward use of the metric system or give legal sanction to our customary system of English origin has been debated on many occasions but has never been answered decisively. In the process, however, many alternative actions were proposed and deliberated upon, a few decisions having permanent significance were made, and the inherently sleep-producing subject of weights and measures was transformed into a sharply contested controversy on several occasions.

In the nearly two centuries of discussion, there have been five major periods of activity with respect to U.S. weights and measures and the metric system, each with its own distinctive objectives and characteristic concerns. These were:

1. THE PERIOD OF CONSOLIDATION (1786-1866)

During this period, emphasis was placed on the achievement of greater internal uniformity in weights and measures by reducing the diversity of units and values that existed from State to State.

Major events that occurred during these years included:

1786—A complete decimal system of coinage was adopted for the United States.

1790—The U.S. Constitution was ratified, whereby the power "to fix the standard of weights and measures" was delegated to Congress. Secretary of State Thomas Jefferson submitted a report on weights and measures to Congress. A basic standard, derived from the motion of the earth on its axis, was proposed along with two alternative plans for a full system of weights and measures—one to "define and render uniform and stable" the weights and measures already in use, the other to establish a decimal system of weights and measures.

In France, King Louis XVI approved an edict announcing a reform of French weights and measures and authorizing appropriate scientific investigations. When carried out, this work led to the development of the metric system.

1795—A French decree was issued officially adopting the metric system. Copies of the provisional standards were sent to several countries, including the United States.

1799—The first Federal weights and measures law was enacted. Known as the "Surveyor Act," it ordered an annual examination of the weights, measures and instruments used in assessing customs duties.

1812—By decree, Napoleon Bonaparte temporarily suspended the compulsory provisions of the 1795 metric system law. He retained the metric standards but restored the pre-Revolutionary unit names and values for French weights and measures.

1821—Secretary of State John Quincy Adams submitted an exhaustive report on the subject of weights and measures to Congress in response to a resolution passed by the Senate in 1817. Adams recommended retention of the English customary system by the U.S., but he proposed a program for achieving greater uniformity among the States. He also recommended that the

President be authorized to negotiate with France, Spain and Great Britain with a view toward achieving uniformity among all four nations.

1828—An Act was passed establishing the Troy pound, a weight of the customary system, as the standard for coinage to be used by the U.S. Mint.

1832—By administrative action, the Secretary of the Treasury, declared the yard, the avoirdupois pound, and the Winchester bushel to be the official system of weights and measures to be used in U.S. custom houses and directed that standards be prepared and distributed.

1836—A joint resolution was passed by Congress directing that sets of the standards adopted by the Treasury Department be prepared and distributed to the States.

1837—A law was passed by the French Government reinstating the metric system to full compulsory standing after January 1, 1840.

1838—A joint resolution providing for delivery of standard balances to each State was passed by Congress.

1863—The National Academy of Sciences was created and chose, as one of its first acts, to establish a committee on weights, measures and coinage.

1864—The Committee on Coinage, Weights and Measures was established as a standing committee of the House of Representatives.

1866—Use of the metric system in the United States was made legal by Act of Congress.

Other Acts were passed by Congress providing for each State to be furnished with a set of standard weights and measures of the metric system and providing for the distribution of metric balances to all post offices exchanging mail with foreign countries.

2. THE EDUCATIONAL MOVEMENT (1866-1889)

During this era, the primary goal of supporters of the metric system was to secure widespread acceptance and voluntary use of the system by educating "the rising generation" as to the advantages offered by it. The basic assumption adopted by Frederick A. P. Barnard and other leaders of the movement was that no further legislation could be passed or would be effective until the people as a whole were ready to exchange their customary weights and measures for new ones. Legislation was proposed during these years, but its main aim was to require Government use of the system in transacting business of an international character—postal exchanges, customs levies, and so on.

The following noteworthy events took place between 1866 and 1889:

1871—After 5 years of deliberation, a report on weights and measures was delivered to the University Convocation of the State of

New York by Professor Charles Davies of Columbia University. Davies' report was almost totally unfavorable to further action with regard to the metric system and was the first completely anti-metric work to appear in print. It was also a trend-setter in terms of the nature and general tone of the arguments advanced.

1872 – The president of Columbia University, Frederick A. P. Barnard, published a pro-metric refutation of Prof. Davies' contentions and set forth recommendations for increasing the use of the metric system in the United States.

1873 – The American Metrological Society was organized in New York by F. A. P. Barnard for the purpose of improving existing systems of weights, measures and moneys and to work for the universal adoption of a common system of weights and measures, preferably the metric system.

1875 – The *Convention du Mètre* (Treaty of the Meter) was signed in Paris by 17 nations, including the United States. The result of several years work, the Treaty provided for the fabrication of new and improved standards for metric weights and measures, the establishment and maintenance of a permanent International Bureau of Weights and Measures, and the creation of a general conference as a permanent deliberative body to pass upon international weights and measures matters. Final U.S. approval of the Treaty was granted in 1878, and it was ratified by President Hayes.

1876 – The American Metric Bureau was established in Boston, Massachusetts. Its president was F. A. P. Barnard, but the management of the Bureau was entrusted to its secretary, Melvil Dewey (who later developed the Dewey decimal system of library classification). The objects of this organization were "to disseminate information concerning the metric system; to urge its early adoption; and to bring about actual introductions wherever possible."

1877 – A resolution was adopted by the House of Representatives requesting the executive branch agencies of the Government to submit reports concerning the desirability of making the use of the metric system obligatory for all Government transactions. They were also asked to state what objections there might be to adopting the metric system for general use and how long a transition period should be allowed. The Government's replies, received in 1878, were generally not favorable to any compulsory law regarding the use of the metric system.

1879 – The International Institute for Preserving and Perfecting (the Anglo-Saxon) Weights and Measures was founded in Boston. This group, the nation's first organized anti-metric society, was led by Charles Latimer, an engineer, from his home in Cleveland, Ohio. Its objectives were to defeat any proposed legislation designed to further the use of the metric system, to preserve the English customary system of weights and measures and work for its improvement and to discuss and disseminate "the wisdom contained in the Great Pyramid of Jeezeh in Egypt."

1880—A denunciation of the metric system and its adherents was published by Charles Latimer in the form of a book entitled *The French Metric System, or, The Battle of the Standards.*

1881—A joint resolution was passed by Congress requiring the Secretary of the Treasury to supply State land grant colleges with sets of weights and measures standards.

Most activites of the American Metric Bureau had been suspended by 1881 due to a shortage of funds and Mr. Dewey's transfer to New York.

1888—Charles Latimer died and the International Institute expired from lack of adequate support.

1889—F.A.P. Barnard died and the American Metrological Society began a process of rapid deterioration.

Fabrication of new international metric standards was completed in France. International prototypes were selected, and copies were distributed to nations that had signed the Treaty of the Meter. The U.S. received prototype meters No. 21 and No. 27 and prototype kilograms No. 4 and No. 20. In 1890, these standards were accepted in a formal ceremony at the White House by President Benjamin Harrison.

3. THE MOVEMENT TO INTRODUCE THE METRIC SYSTEM THROUGH GOVERNMENT ADOPTION (1890-1914)

In this time period the supporters of the metric system adhered to a strategy which called for rapid adoption of the system by the Government, followed by a general transition on the part of the rest of the U.S. after a brief introductory period. The main assumptions which were behind this movement were: (1) that the eventual acceptance of the metric system was inevitable; (2) that the people of the Nation could not fail to appreciate the superior advantages of the metric system once they had gotten first-hand experience in using it; and (3) that the best way to acquaint the greatest number of people with the system was by adopting it for all Government work. With very few exceptions, the legislation proposed during this period was aimed at implementing this strategy.

The outstanding events that occurred between 1890 and 1914 were:

1893—Congress enacted a law establishing gauges for sheet and plate iron and steel. Standard thickness and weights were specified in both customary and metric units.

Thomas C. Mendenhall, the Superintendent of Weights and Measures, issued a Treasury Department Bulletin announcing that the U.S. prototype meter and kilogram would henceforth be considered the nation's "fundamental standards of length and mass." Under the new procedures adopted by Mendenhall, units of the English customary system were defined not by their own standards but by carefully specifying what fraction of a meter would constitute a yard and what fraction of a kilogram would constitute a pound.

1894 – A law defining and establishing units for electrical measurement was passed by Congress. These units were based on the metric system.

1895 – A resolution establishing a commission to study and report on the feasibility of metric adoption was passed by the House of Representatives. By mistake, the resolution was recorded as requiring the concurrence of the Senate in order to be put into effect. Consequently, the commission was never formally organized and only brief reports by a few Government agencies resulted.

1896 – Following hearings by the House Committee on Coinage, Weights and Measures, a bill requiring Government adoption of the metric system was taken up by the House of Representatives. After passing the bill one time, the House voted to reconsider its action and the measure was then sent back to the Committee for further consideration. Despite several subsequent attempts to revive the bill, no additional action was taken.

1897 – Legislation was enacted by Great Britain permitting full use of the metric system.

1901 – The National Bureau of Standards was established by Act of Congress, and Samuel Wesley Stratton was appointed to be its first director.

1902 – Extensive hearings on proposed Government adoption of the metric system were held by the Committee on Coinage, Weights and Measures, at which serious opposition began to develop. A favorable Committee report was issued (from which no action resulted) but this was to be the last such report for 35 years.

Adoption of the metric system was made the main topic of discussion at the annual meeting of the American Society of Mechanical Engineers in New York. On the basis of a strongly anti-metric report submitted by a special committee and a paper prepared by Frederick A. Halsey, the Society declined to give approval to pending legislative proposals.

1904 –
1906 – A series of exhaustive hearings on the question of metric adoption was conducted by the House Committee on Coinage, Weights and Measures.

1904 – A book of arguments against the metric system, entitled *The Metric Fallacy*, was co-authored by Frederick A. Halsey and Samuel S. Dale.

1905 – The first National Conference on Weights and Measures, sponsored by the National Bureau of Standards, was held at

Washington, D.C. One of the stated objectives of the Conference was to secure uniformity of laws pertaining to weights and measures throughout the United States. Activities along these lines were interpreted by anti-metric interests as an attempt to force metric adoption on the people.

1907 – Following a refusal by the Committee on Coinage, Weights and Measures to report favorably on a metric bill, intense promotional efforts on behalf of the system died down until the advent of World War I.

4. THE PROPAGANDA PERIOD (1914-1933)

During this era, those who were expounding both sides of the metric question relied heavily on direct public appeals as the principal means of conducting their respective campaigns. On the pro-metric side of the fence, the objective was simply to secure the passage of any legislation that would tend to promote greater use of the metric system. On the anti-metric side, all Government activities or proposed actions were carefully scrutinized and those that contained any pro-metric provisions at all were thoroughly opposed. Consequently, no single pattern emerged from the legislation proposed during these years. In general, however, the legislation was totally different from that put forth in earlier decades; it was aimed chiefly at securing the use of the metric system in daily commercial transactions; and it contained provisions exempting manufacturers from the compulsory requirements of the law.

Major events which took place between 1914 and 1933 included:

1916 – A pro-metric report was prepared by S. W. Stratton for use by American members of the International High Commission. It was entitled *The Metric System in Export Trade,* and it set the trend for many of the pro-metric arguments of this era.

The American Metric Association was founded in New York. The leaders of this pro-metric group included Dr. George Kunz, its president during these years, Howard Richards, Frederick Roberts and Dr. Stratton. The organization's goal was to secure the general use of the metric system, and its approach to the problem involved heavy reliance on scientific, educational and professional organizations.

The anti-metric American Institute of Weights and Measures was organized, also in New York. The brainchild of Frederick A. Halsey and Samuel S. Dale, the Institute's main objective was "opposition to hasty and ill-considered legislation involving changes from our fundamental standards." Support for the organization's activities was provided by some of the nation's leading manufacturers. The president of the Institute was Walter Renton Ingalls, but most of the work was carried out by successive secretaries, including Halsey, Luther D. Burlingame, Charles C. Stutz and William E. Bullock.

1918 – General Order No. 1 was issued by the War Department providing for the use of the metric system for wartime activities.

A committee of the American Society of Mechanical Engineers issued an anti-metric rebuttal to Dr. Stratton's 1916 report on export trade and Frederick Halsey published a paper on "The Weights and Measures of Latin America" which purported to prove that the metric system had failed to gain acceptance in all but one country in that region.

Secretary of Commerce William C. Redfield, in an address to the Metric Association, advocated adoption of the system and implied that German industrial strength had been materially aided by her switchover in 1871.

1919 – The World Trade Club began operations in San Francisco, California. Financed by a wealthy manufacturer named Albert Herbert and operated by an advertising man named Aubrey Drury, this group was chiefly a publicity organization formed to promote U.S. adoption of the metric system. Between 1919 and 1921, the World Trade Club issued a barrage of pro-metric propaganda and lobbied for Congressional support by retaining a representative in Washington, D.C., W. Mortimer Crocker. Although the group's name was changed in subsequent years, to the World Metric Standardization Council (1920) and the All-America Standards Council (1924), its objectives, method of operation, and personnel remained basically the same.

1920 – A massive petitioning campaign was launched by the World Trade Club in an attempt to flood Washington with pro-metric postal cards. Eventually, more than 100,000 petitions were received. This activity touched off a counter-campaign that was spearheaded by Nathan Viall, the editor of *American Machinist* magazine.

A second, and revised, edition of *The Metric Fallacy* was published by Frederick Halsey and the American Institute of Weights and Measures.

1921 – Between October, 1921 and March, 1922 extensive hearings on a metric adoption bill were held by a subcommittee on the Senate Committee on Manufactures. It marked the first consideration of the metric issue by the Senate since 1866.

The National Industrial Conference Board conducted an in-depth study of the advantages and disadvantages of both the metric system and the English customary system of weights and measures. Its findings led them to conclude that the English system should be retained.

1922 – Aubrey Drury compiled and published a comprehensive collection of pro-metric contentions in a large volume entitled *World Metric Standardization: An Urgent Issue*.

1923 – Samuel Stratton, who had been severely criticized for using the National Bureau of Standards to promote the metric system, resigned to become president of the Massachusetts Institute of

Technology. He was succeeded as director of NBS by George Kimball Burgess, who, in time, was also accused of fostering a pro-metric attitude on the Bureau's part.

1924 – The first Pan-American Standardization Conference was held at Lima, Peru. Despite the hopes of metric advocates, no action to promote adoption of the system was approved by the Conference.

1926 – Congressional hearings on a metric system bill were held by the House Committee on Coinage, Weights and Measures for the first time in 20 years. After the Committee declined to issue a favorable report on the bill, several different resolutions were proposed calling for a study of the question or for the general use of metric units in merchandising. No favorable action was taken with respect to these bills, either.

1931 – After 5 years of gradual decline, intense agitation for adoption of the metric system ceased. The World Trade Club and its successors had folded by 1931, and the American Institute of Weights and Measures had largely disappeared. The Metric Association remained in existence, but it suspended almost all operations and mounted no major campaign on behalf of the system after 1931.

5. THE COMPREHENSIVE STUDY PHASE (1934–1968)

After a 25-year interruption, the question of U.S. acceptance of the metric system again bacame an active topic of discussion. During the latest period, which occurred between 1959 and 1968, the emphasis was placed on securing legislation to authorize a comprehensive investigation of the many facets of this question by the Federal Government. In 1968, legislation directing the Secretary of Commerce to conduct such a study was enacted by Congress.

Other events which have taken place since the depression include:

1937 – A bill to fix the standards according to the weights and measures of the metric system and to define by law the units of the English customary system was considered and recommended by the Committee on Coinage, Weights and Measures. Although the bill was never enacted, the action represented the first Congressional report involving the metric system since 1902 and the last such report delivered by that particular Committee.

1946 – The House Committee on Coinage, Weights, and Measures was abolished by the Legislative Reorganization Act of 1946.

1948 – The "Twentieth Yearbook of the National Council of Teachers of Mathematics" was given over solely to a discussion of the need for and advantages of using the metric system, particularly for educational purposes.

1950 – Congress enacted a law which redefined the units for electrical and photometric measurements and established legal standards for both types. This law was essentially a modernization of the 1893 Act dealing with electrical measurements.

1951—A committee of the British Board of Trade submitted a report to Parliament that contained recommendations for adopting the metric system.

1957—The U.S. Army issued a regulation establishing metric linear units as the basis for weapons and related equipment.

1958—The Committee on Science and Astronautics was created as a standing committee by the House of Representatives.
By concurrent action on the part of several national standards laboratories, the values for the customary pound and yard in the U.S. were aligned with the values accepted by Australia, Canada, New Zealand, South Africa, and the United Kingdom for the first time.

1959—With investigations of the metric system in progress in both the U.S. and Great Britain, Secretary of Commerce Lewis Strauss urged American adoption of the system in an address to the American Physical Society.

Legislation proposing a Government program of "investigation, research and survey" into the question of metric adoption was introduced in the 86th Congress. Similar legislation was proposed in succeeding Congresses, with significant variations, until 1968. Another class of legislation that was consistently proposed during these years called for the initiation of a program to increase the use of the metric system without prior study.

1960—A report was published in Great Britain that recommended against official action with respect to the metric system of weights and measures.

At the 11th General Conference on Weights and Measures, a new international standard of length, based on the wavelength of the element krypton, was adopted in place of the original "meter bar." At the same Conference, the modernized metric system was officially re-named the *Système International d'Unités*—the International System of Units.

1961—The first hearings on proposals to study the metric question were conducted by the House Committee on Science and Astronautics. A favorable report was issued and the bill was placed on the Consent Calendar of the House. At each discussion, however, it was passed over without consideration.

1964—The Senate Committee on Commerce held its first hearings on a metric study bill.

1965—The president of the British Board of Trade, with the approval of the Government, announced plans for the conversion of Great Britain to the metric system "sector by sector" over a 10-year period.

After hearings in both the House and the Senate, legislation providing for a study was passed by the Senate but held up by the House Committee on Rules.

1968—An Act providing for a 3-year program to determine the impact of increasing use of the metric system on the United States was passed by Congress and signed into law by President Lyndon B. Johnson.

Throughout all of these years, the arguments both for and against the metric system and its adoption by the U.S. have, with only a few exceptions, remained basically unchanged. They may be summarized as follows:

I. THE PRO-METRIC CASE

A. The metric system is an inherently superior system because of its scientific origins, its decimally-based configuration, and its precise nomenclature.

1. Because the keystone of the metric system, the length standard, is invariable and infinitely reproducible by virtue of its natural origins, it is immune from destruction, well suited for precision measurement work, and international in character.
2. The interrelationships between the units and standards for length, mass and volume, and the progression of sub-units and multiples in ratios of 1:10 make the metric system much simpler to learn and use than the customary system. The value of decimalization has already been demonstrated by our system of currency, and by the fact that the English system of weights and measures is usually decimalized when extra-fine measurements are required. In addition, calculations involving weights and measures would be greatly facilitated by the adoption of a decimal system and fewer errors would occur because an erroneously-placed decimal point is easy to notice.
3. The nomenclature of the metric system is to be preferred because there are fewer names to learn (only 3 basic ones), each one is unique and not subject to being confused with other words having the same name but different meanings (such as "foot" and "yard"), and the system of prefixes adopted for use with the unit names is consistent and meaningful.
4. By comparison, the English customary system of weights and measures is difficult to learn, cumbersome to use, not interrelated in its parts and ambiguous in its terminology.

B. The metric system of weights and measures has achieved almost universal acceptance among the other nations of the world, and it would be to the benefit of the United States to adopt it also.

1. One by one, all of the major nations of the world except the United States (and, until 1965, Great Britain) have gone over to the metric system, if not for most daily uses, at least for official purposes. With all nations becoming increasingly interdependent, and with the United States seeking to play a leadership role in

world affairs, it behooves us to stop obstructing the completion of this desirable reform.

2. If Great Britain should decide to adopt the metric system (which it did in 1965), the United States would be left alone in its adherence to the English customary system or we would have to begin our own process of conversion. The U.S. should not be forced into such a decision, nor should it have to make the switch in a hurried and wasteful manner. We should lead rather than follow. If, on the other hand, the U.S. should decide to adopt the metric system first, we would not be injuring our relationship with Great Britain, because Britain would be sure to adopt it, too. Ideally, of course, the two nations would decide on a simultaneous course of action, but, failing that, there is no reason why we shouldn't take the first step.
3. Neither the English customary system nor any other system of weights and measures but the metric system can ever become universal. The metric system is too widely accepted and, besides, no nation which has ever adopted it has given it up.
4. Since 1866 the metric system has been officially recognized in this country. Since that time, also, the use of the metric system in this country has been growing—our official standards are metric ones, it is the system universally used in science and in certain branches of engineering, and some industries are using it almost exclusively.
5. The benefits to be gained by adopting the metric system include increased foreign trade, the saving of time in education, and increased efficiency and lower costs in domestic industrial design and production.

C. The contentions and fears of opponents of the system notwithstanding, adoption of the metric system is practicable.

1. It would not be necessary to abandon or rebuild existing machines in order to make the change. Old machines could simply be replaced as they wear out by new machines manufactured in the metric system.
2. Most manufactured articles could be made to the same dimensions using existing drawings, gauges, dies, etc. It would simply be necessary to label and advertise the final product in metric units.
3. It would be possible to arrange for the gradual introduction of the metric system in such a way that any confusion or economic burden would be minimized, if not eliminated altogether.
4. The cost of changing to the metric system has been severely overestimated, and what costs there will be can be spread over a period of many years.
5. If there are psychological difficulties in adjusting to the foreign nomenclature, it would be possible to simply call the meter a "world yard," the liter a "world quart" and so on.

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6. Other nations have adjusted easily to the switch and it has been to their benefit. The people of the U.S., being better educated, less inclined to cling to tradition, and amenable to the acceptance of technological change accompanied by economic benefit, would certainly be able to adjust to the metric system as easily as other peoples have.

D. The eventual widespread use of the metric system in the United States is inevitable, and it is preferable to make the transition in a planned and orderly manner.

E. Under the Constitution, the power "to fix the standard of weights and measures" was given to Congress. This authority has never been exercised.

II. THE ANTI-METRIC CASE

A. There is no need to change from the English customary system of weights and measures.

1. The U.S. has greater uniformity of weights and measures using the customary system than exists in any other country on earth.
2. The majority of world trade is conducted on the basis of the customary system because world trade is dominated by English-speaking nations.
3. The English system has intrinsic merits of its own. Oftentimes, repeated binary division of weights and measures is more convenient. The customary system was the result of continuous improvement over a long period of time. The English system also has special units for special purposes which make it irreplaceable.
4. The decimal principle can be applied to the units of the customary system where that is necessary or advantageous. The weights and measures of the metric system, however, are not readily amenable to repeated binary division.
5. The conditions which existed in pre-metric Europe—diversity, confusion, and fraud—do not exist in the United States.
6. The customary system can be, and should be, improved and simplified, but that is not an argument for discarding it altogether.
7. There is no widespread demand for a change. Manufacturers, engineers, shopkeepers, workmen, and the people as a whole do not want it. The demand for metric adoption is an artificial one, created by a handful of scientists, educators, and government officials.

B. The disadvantages of adopting the metric system would outweigh any benefits.

1. In place of a single, widely-used system of weights and measures, upon which all industrial standards and manufacturing practices are based, we would have to cope with two systems of weights

and measures. Enormous confusion would result from this simultaneous employment of a dual system.

2. Ingrained customs and commercial relationships (such as the price for a given unit of weight or volume of a commodity) would be destroyed.
3. Adoption of the metric system would have very little impact on education or foreign trade. Both systems would have to be learned in the schools, and our domination of foreign trade has made other nations familiar with the customary system.

C. In comparatively few countries has the acceptance of the metric system been complete. Even though it may have been adopted for official purposes, it is not used in manufacturing or by the great majority of the people in their daily affairs. Only where despots and dictators have been able to enforce their will by police power has the metric system been rapidly assimilated.

D. Adoption of the metric system would be impractical and costly.

1. Tools and machinery would have to be discarded, drawings would have to be re-done, etc.
2. A vast amount of technical literature would be nullified.
3. All land measurements, deeds and titles would have to be changed, as would such things as railway mileposts, tariff schedules and highway signs.
4. The experience of workmen, built up over years, would be thrown away. The result would be increased spoilage, a slowdown in production, and increased cost.
5. To simply label a product manufactured to English-system specifications in metric-system equivalents would be costly. This would not constitute adoption of the metric system, anyway. Why not continue to call an "inch" an "inch" instead of 2.54 centimeters?

E. Compulsory adoption of the metric system by legislation would be unacceptable.

1. The metric system has been legal for use in this country since 1866. Anyone who wants to use it may do so. The fact that it isn't being used under these conditions is adequate testimony to the need and demand for further action.
2. Compulsion is repugnant to American ideals. Americans can be led but they cannot be pushed. Any attempts to force the metric system on the nation would probably meet strong resistance.

As this account has shown, the arguments of the anti-metric forces have generally been persuasive enough to prevent the supporters of the metric system from successfully prosecuting their legislative program. The reasons why such legislation failed have varied from generation to generation, changing with the times. But John Quincy Adams, in his 1821 *Report Upon Weights and Measures*, probably summarized all of them most adequately when he wrote:

"The substitution of an entire new system of weights and measures, instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is indeed no difficulty in enacting and promulgating the law; but the difficulties of carrying it into execution are always great, and have often proved insuperable. Weights and measures may be ranked among the necessaries of life, to every individual of human society. They enter into the economical arrangements and daily concerns of every family. They are necessary to every occupation of human industry; to the distribution and security of every species of property; to every transaction of trade and commerce; to the labors of the husbandman; to the ingenuity of the artificer; to the studies of the philosopher; to the researchers of the antiquarian; to the navigation of the mariner and the marches of the soldier; to all the exchanges of peace, and all the operations of war. The knowledge of them, as in established use, is among the first elements of education, and is often learnt by those who learn nothing else, not even to read and write. This knowledge is rivetted in the memory by the habitual application of it to the employments of men throughout life. Every individual, or at least every family, has the weights and measures used in the vicinity, and recognized by the custom of the place. To change all this at once, is to affect the well-being of every man, woman, and child, in the community."

Appendix A

REFERENCES

CHAPTER I: INTRODUCTION

[1] U.S. Department of State. *Report of the Secretary of State Upon Weights and Measures.* Washington: 1821. p. 6.

[2] U.S. National Bureau of Standards. *Units and Systems of Weights and Measures—Their Origin, Development and Present Status;* (Letter Circular 1035). Washington: 1960. p. 2.

[3] Hallock, William and Wade, Herbert T. *Outlines of the Evolution of Weights and Measures and the Metric System.* New York: 1906. p. 6.

[4] U.S. National Bureau of Standards. *Letter Circular 1035*. p. 2.

[5] Huntoon, R. D. "The Concept of a National Measurement System." *Science,* Vol. 158, No. 3797 (October 6, 1967). p. 68.

[6] Hallock and Wade. *Op. Cit.* p. 5.

[7] See, for example, Hallock and Wade, *Op. Cit.*, "Chapter I: Origin and Development of the Science of Metrology," pp. 1-40; Sir Flinders Petrie's *Ancient Weights and Measures* (London: 1926); and H.W. Chisholm's *On The Science of Weighing and Measuring* (London: 1877).

Interestingly, so few works have been devoted to the history of weights and measures in recent years that the efforts of late 19th and early 20th century scholars must still be considered authoritative. Fortunately several well-documented works were produced during this period of time so that there need be no lack of confidence in the research because of a paucity of source citations.

[8] U.S. Department of State. *Op. Cit.* p. 6.

[9] Hallock and Wade. *Op. Cit.* p. 9.

[10] Ford Motor Company. *Measuring Systems and Their History.* Dearborn, Michigan: 1966. pp. 7-9.

[11] Hallock and Wade. *Op. Cit.* p. 6.

[12] Ford Motor Company. *Op. Cit.* p. 8.

[13] *Ibid.* p. 9.

[14] Hallock and Wade. *Op. Cit.* p. 4. Mention is also made of the fact that the so-called medical papyri of Egypt make no reference to common weights, the most natural place to expect them to be found.

[15] Hallock and Wade. *Op. Cit.* p. 4.

[16] *Ibid.* p. 17.

[17] Ford Motor Company. *Op. Cit.* pp. 9-10.

[18] Nicholson, Edward. *Men and Measures.* London: 1912. p. 189; and Ford Motor Company. *Op. Cit.* p. 8.

[19] Hallock and Wade. *Op. Cit.* p. 12.

[20] Stiehler, R. D. *History of Measurement and the S.I. Units.* (Unpublished manuscript). U.S. National Bureau of Standards. 1969.

[21] Hallock and Wade. *Op. Cit.* pp. 24-25.

[22] *Ibid.* p. 26.

[23] *Ibid.*

[24] *Ibid.*

[25] *Ibid.*

[26] Ford Motor Company. *Op. Cit.* p. 9.

[27] *Ibid.* p. 12.

[28] Chisholm, H. W. *On the Science of Weighing and Measuring.* London: 1877. p. 48.

[29] *Ibid.*

[30] *Ibid.* p. 30.

[31] Hallock and Wade. *Op. Cit.* p. 3.

[32] *Ibid.*

[33] *Ibid.* p. 33.

[34] Moreau. Henri (as translated by Ralph E. Oesper). "The Genesis of the Metric System and the Work of the International Bureau of Weights and Measures." *Journal of Chemical Education;* Vol. 30, No. 1 (January 1953). p. 3.

[35] Langevin, Luce. "The Introduction of the Metric System." *Impact of Science on Society;* Vol. 11, No. 2 (August, 1961). p. 77.

[36] Hallock and Wade. *Op. Cit.* p. 43. These authors cite Mouton directly so they have been liberally used in preparing this section. Their citation is as follows: Mouton, *Observationes diametrorum Solis et Lunae . . . Huic adjecta est brevis dissertatio de . . . nova mensurarum geometricarum idea* (Lyons, 1670).

[37] Hallock and Wade. *Op. Cit.* p. 43.

[38] *Ibid.*

[39] *Ibid.*

[40] *Ibid.* p. 46.

[41] Hallock and Wade. *Op. Cit.* pp. 46-47. Taken from Bigourdan, *Le Système Métrique;* Paris, 1901; in which is to be found "the text of all French legislation and the salient features of discussion by lawmakers and scientists, as well as a complete bibliography."

[42] Hallock and Wade. *Op. Cit.* p. 47.

[43] *Ibid.* pp. 48-49.

[44] U.S. National Bureau of Standards. *Units of Weight and Measure* (Miscellaneous Publication 286). Washington: 1967. p. 4.

[45] Hallock and Wade. *Op. Cit.* p. 49.

[46] *Ibid.* p. 69.

[47] *Ibid.* p. 61.

[48] *Ibid.* p. 63.

[49] This convocation, as seen through the eyes of Thomas Bugge, Danish Astronomer Royal and delegate to the conference, is described in Maurice Crosland's *Science in France in the Revolutionary Era* (Boston: 1969) on pages 195-211.

[50] Crosland, Maurice P., ed. *Science in France in the Revolutionary Era.* Boston: 1969. p. 197.

[51] Hallock and Wade. *Op. Cit.* p. 64.

[52] *Ibid.* pp. 65-66.

[53] *Ibid.* pp. 67-68.

[54] Langevin, *Op. Cit.* p. 93.

[55] Urbancek, Joseph J. "Later Trends in Metric Usage." *The Metric System of Weights and Measures* (J. T. Johnson, ed.). New York: 1948. p. 35.

[56] Cox, Edward F. "The Metric System: A quarter-century of acceptance (1851-1876)." *Osiris* (Belgium). Vol. XIII (1959). pp. 376-377.

CHAPTER II: TOWARD A MORE PERFECT UNIFORMITY (1607-1860)

[1] U.S. Department of State. *Report of the Secretary of State Upon Weights and Measures.* Washington: 1821. p. 109.

As a part of his report, John Quincy Adams includes an appendix detailing the weights and measures laws of all the States in the Union at that time. His detailed account has been used as the primary source of colonial legislation having to do with weights and measures. An extensive collection of State laws on weights and measures is also shelved in the Library at the National Bureau of Standards.

[2] U.S. National Bureau of Standards. *Weights and Measures in Congress;* by Sarah Ann Jones (Miscellaneous Publication M122). Washington: 1936. p. 3.

Miss Jones' brief (19 pages) summary covering the period of the Continental Congress up to and including the adoption of the Joint Resolutions of 1836 and 1838, is extremely valuable because of its meticulous attention to documentation of original source material.

[3] Hellman, C. D. "Jefferson's Efforts Towards the Decimalization of United States Weights and Measures." *Isis;* Vol. XVI, No. 2 (November 1931). p. 267.

This paper has provided the primary source of reference for the discussions of both decimal coinage and Jefferson's efforts on weights and measures in this account.

[4] *Ibid.*
[5] *Ibid.* p. 268.
[6] *Ibid.*
[7] *Ibid.* p. 269.
[8] *Ibid.*
[9] *Ibid.*
[10] *Ibid.* p. 270.
[11] *Ibid.* p. 272.
[12] *Ibid.* p. 273.
[13] *Ibid.* pp. 273-277.
[14] U.S. Department of State. *Op. Cit.* p. 56.
[15] Hellman. *Op. Cit.* p. 282.
[16] *Ibid.* p. 283.
[17] Jones. *Op. Cit.* p. 3.
[18] Hellman. *Op. Cit.* p. 290.
[19] *Ibid.*
[20] *Ibid.*

Some of Jefferson's interesting correspondence with Rittenhouse is appended to the Hellman paper. Her source for it is *The Writings of Jefferson.* Library Edition (Washington: 1903).

[21] *Ibid.* p. 294.
[22] *Ibid.* p. 295.
[23] *Ibid.* p. 292.
[24] U.S. Department of State. *Report of the Secretary of State, on the Subject of Establishing a Uniformity in the Weights, Measures and Coins of the United States.* New York: 1790. p. 39.
[25] Hellman. *Op. Cit.* p. 296.
[26] *Ibid.*
[27] *Ibid.* p. 297.
[28] *Ibid.* p. 286.
[29] *Ibid.* pp. 286-287.
[30] Data on the period from 1790-1819 have been obtained from Jones, *Weights and Measures in Congress,* pages 4 through 10.
[31] U.S. Congress. *Annals of Congress.* Vol. 2. (Senate; March 1, 1791).
[32] Jones. *Op. Cit.* p. 5.
[33] U.S. Department of State. *Report . . . Upon Weights and Measures* (John Quincy Adams). p. 54.
[34] *Ibid.*
[35] Jones. *Op. Cit.* p. 7.
[36] *Ibid.*
[37] Fischer, Louis A. *History of the Standard Weights and Measures of the United States.* (Miscellaneous Publication, Bureau of Standards, No. 64).

When this publication was updated by the U.S. National Bureau of Standards in 1963, the discussion of the "committee meter" was eliminated. There are also several other topics more fully discussed by Mr. Fischer than in later versions, so that both editions will be of interest to those wishing to pursue the history of U.S. weights and measures in greater detail.

[38] The story of the Troughton scale is contained in an article entitled "The Metric System" by Samuel Wesley Stratton, first Director of the National Bureau of Standards. A copy of this paper, delivered to a meeting of the Eastern Association of Physics Teachers on March 19, 1904, is on file at the Library of the National Bureau of Standards (Accession No. 8319).
[39] U.S. Congress. *Annals of Congress.* Vol. 30 (Senate, December 3, 1816).
[40] *Letters and Other Writings of James Madison.* Vol. I. (Philadelphia: 1865). pp. 152-153.
[41] U.S. Department of State. *Report . . . Upon Weights and Measures* (John Quincy Adams). p. 5.

[42] Jones. *Op. Cit.* p. 10.

[43] For this account of Adams' report, only the original document itself has been relied upon. For this reason, further citations will be given only when verbatim passages are included that require page references. The full citation for this report is: U.S. Department of State Upon Weights and Measures. Washington: 1821.

[44] *Ibid.* pp. 11-12.

[45] *Ibid.* p. 14.

[46] *Ibid.* pp. 19-20

[47] *Ibid.* p. 79.

[48] *Ibid.* pp. 12-13.

[49] *Ibid.* p. 48.

[50] *Ibid.* p. 91.

[51] *Ibid.* p. 90.

[52] *Ibid.* p. 118.

[53] *Ibid.* pp. 118-119.

[54] *Ibid.* p. 121.

[55] *Ibid.* p. 125.

[56] *Ibid.*

[57] Hellman. *Op. Cit.* pp. 287-288.

[58] U.S. Department of State. *Report . . . Upon Weights and Measures* (John Quincy Adams). p. 134.

[59] *Ibid.* pp. 134-135.

[60] Jones. *Op. Cit.* p. 11.

[61] *Ibid.* p. 12.

[62] *Ibid.*

[63] *Ibid.*

[64] *Ibid.* p. 14.

[65] Fischer. *Op. Cit.* p. 7.

[66] *Ibid.* p. 5.

[67] *Ibid.*

[68] Jones. *Op. Cit.* p. 15.

[69] *Ibid.* p. 16.

CHAPTER III: AN ACT TO AUTHORIZE THE USE OF THE METRIC SYSTEM (1861–1866)

[1] National Academy of Sciences. *A History of the First Half-Century of the National Academy of Sciences, 1863-1913.* Washington: 1913. pp. 113-114.

[2] U.S. Congress, House of Representatives; Committee on Coinage, Weights, and Measures; *Coinage, Weights, and Measures,* Report No. 62, 39th Congress, 1st Session; to accompany bills H.R. Nos. 596 and 597, and H. Res. No. 141; May 17, 1866; p. 9.

[3] *Ibid.* (Cited as: Executive Document 84, 30th Congress, 1st Session, July 30, 1848.)

[4] *Ibid.*

[5] *Ibid.* p. 10.

[6] Hallock, William and Wade, Herbert T. *Outlines of the Evolution of Weights and Measures and the Metric System.* New York: 1906. p. 248.

[7] Fischer, Louis A. *History of the Standard Weights and Measures of the United States;* Miscellaneous Publications, Bureau of Standards. No. 64. Washington: 1925. p. 12.

[8] Cox, Edward F. "The Metric System: A Quarter-Century of Acceptance (1851-1876)." *Osiris.* Vol. XIII. (1959). pp. 362-363.

[9] *Ibid.* p. 364.

[10] *Ibid.* pp. 364-365.

[11] *Ibid.* p. 368.

[12] *Ibid.* pp. 369-370.

[13] Hallock and Wade. *Op. Cit.* p. 125.

[14] U.S. Congress, House of Representatives. *Op. Cit.* p. 10.

[15] *Ibid.*
[16] *Ibid.*
[17] *Ibid.*
[18] *Ibid.* p. 11.
[19] *Ibid.*
[20] Reingold, Nathan. *Science in Nineteenth-Century America.* New York: 1964. pp. 200-201.
[21] National Academy of Sciences. *Op. Cit.* pp. 206-207.
[22] *Ibid.* p. 207.
[23] U.S. Congress, House of Representatives, *Op. Cit.* pp. 11-12.
[24] U.S. Congress, House of Representatives. *Hind's Precedents of the House of Representatives of the United States, Vol. IV.* House Document No. 355; 59th Congress, 2nd Session. Washington: 1907. pp. 734-736.
[25] U.S. Congress, House of Representatives. *Biographical Directory of the American Congress, 1774-1927.* House Document No. 783; 69th Congress, 2nd Session. Washington: 1928. p. 1167.
[26] *The Congressional Globe.* U.S. House of Representatives; 38th Congress, 1st Session (1864) p. 1763.
[27] *Ibid.* p. 2265.
[28] *Ibid.* p. 3239.
[29] National Academy of Sciences. *Op Cit.* pp. 208-209.
[30] U.S. Congress, House of Representatives. *Coinage, Weights, and Measures;* (Report No. 62). p. 11.
[31] *Ibid.*
[32] *Ibid.* p. 2.
[33] *Ibid.* pp. 3-4.
[34] *Ibid.* p. 4.
[35] *Ibid.* pp. 8-9.
[36] *Ibid.* p. 12.
[37] *Ibid.* p. 2.
[38] *Ibid.* p. 20.
[39] *The Congressional Globe.* 39th Congress, 1st Session (1866). p. 2653.
[40] *Ibid.* pp. 4216-4219.
[41] *Ibid.* p. 4219.

CHAPTER IV: A PINT'S A POUND THE WORLD AROUND? (1866-1890)

[1] Barnard, Frederick A. P. *The Metric System of Weights and Measures.* New York: 1872. pp. 3-4.
[2] Davies, Charles. *The Metric System.* New York: 1871.
[3] *Ibid.* p. 41.
[4] *Ibid.* pp. 48-49.
[5] *Ibid.* p. 38.
[6] *Ibid.* p. 49.
[7] *Ibid.* p. 39.
[8] *Ibid.* p. 40.
[9] *Ibid.* pp. 45-46.
[10] Barnard. *Op. Cit.*
[11] *Ibid.* p. 5.
[12] *Dictionary of American Biography.* Vol. I. pp. 619-621.
[13] *Ibid.* p. 620.
[14] Barnard. *Op. Cit.* p. 71.
[15] *Ibid.* pp. 75-76.
[16] *Ibid.* p. 85.
[17] *Ibid.* p. 90.
[18] *Ibid.* p. 103.

[19] *Ibid.* p. 107.
[20] *Ibid.* pp. 107-108.
[21] *Ibid.* pp. 108-111.
[22] Hallock, William and Wade, Herbert T. *Outlines of the Evolution of Weights and Measures and The Metric System.* New York: 1906. p. 70.
[23] *Ibid.*
[24] National Academy of Sciences. *A History of the First Half-Century of the National Academy of Sciences. 1863-1913.* Washington: 1913. p. 117.
[25] Hallock and Wade. *Op. Cit.* p. 70.
[26] *Ibid.* p. 71.
[27] *Ibid.*
[28] Cox, Edward F. "The Metric System: a quarter-century of acceptance (1851-1876)." *Osiris.* Vol. XIII, (1959). p. 372.
[29] *Ibid.*
[30] Hallock and Wade. *Op. Cit.* p. 100.
[31] *Ibid.*
[32] Cox. *Op. Cit.* p. 373.
[33] National Academy of Sciences. *Proceedings.* Vol. I. (1867). pp. 62-63.
[34] *Ibid.*
[35] General information concerning the legislative activities of this period has been pulled together from a variety of public documents, including:

a. *The Congressional Globe* (prior to Dec. 1873)
b. *The Congressional Record* (after Dec. 1873)
c. The Library of Congress' record set of bound volumes of all Bills introduced; filed serially by Congress.
d. The Library of Congress' serial set of Congressional documents.
e. A *Checklist of Hearings before Congressional Committees through the 67th Congress;* edited by Harold O. Thomen. Published by the Library of Congress; Washington: 1959.
f. An *Index of Congressional Committee Hearings* (prior to January 3, 1935); edited by Edwin A. Halsey. Published by the U.S. Senate. Washington: 1935.

Routine committee activities are, for the most part, taken from the *Globe* or *Record;* all bills referenced are to be found in the volumes indicated in c., above, etc. For this reason, exact citations of sources will not be indicated in many cases. Hearings, Reports, Congressional debates and other actions of major significance to the history of the system will be properly referenced, however.

[36] Hallock and Wade. *Op. Cit.* p. 71.
[37] *Ibid.*
[38] *Ibid. p. 72.*
[39] U.S. Congress. House of Representatives. *Misc. Doc. No. 61;* 45th Cong., 2nd Sess. Committee on Coinage, Weights, and Measures. "Statement of Professor J. E. Hilgard Concerning the Standard Weights and Measures of the United States"; June 3, 1878.
[40] Moreau, Henri. "The Genesis of the Metric System and the Work of the International Bureau of Weights and Measures" (Translated by Ralph E. Oesper). *Journal of Chemical Education.* Vol. 30 (Jan. 1953) p. 9.
[41] Fischer, Louis A. *History of the Standard Weights and Measures of the United States.* U.S. Bureau of Standards (Miscellaneous Publication No. 64). Washington: 1925. p. 20.
[42] *Ibid.*
[43] Cochrane, Rexmond C. *Measures for Progress.* U.S. National Bureau of Standards (Miscellaneous Publication 275). Washington: 1966. p. 30.
[44] Fischer. *Op. Cit.* pp. 20-21.
[45] *Ibid.* p. 21.
[46] Cochrane. *Op. Cit.* p. 531.
[47] Moreau. *Op. Cit.* p. 10.
[48] *Ibid.* p. 11.
[49] House Misc. Doc. No. 61 (1878).

[50] There are three excellent sources of further information on the technical processes used and the problems encountered in manufacturing these standards:

(1) Moreau, *Op. Cit.*, pp.11-14.
(2) Hilgard, in House Misc. Doc. No. 61 of 1878; and
(3) Gould, Benjamin Apthorp. *Address on the Metric System of Weights and Measures,* printed by The Commercial Club of Boston; 1888.

Of these, Gould's is probably the most interesting as well as the most reliable, as he was the U.S. Representative on the International Committee at the time the work was completed.

[51] Fischer. *Op. Cit.* p. 21.
[52] *Ibid.*
[53] U.S. Treasury Department, Coast and Geodetic Survey. *Bulletin No. 26: Fundamental Standards of Length and Mass.* April 5, 1893.
[54] American Metrological Society. *Proceedings.* Vol. I (1873-1878). pp. 3-4.
[55] *Ibid.* pp. 13-14.
[56] *Ibid.* pp. 14-15.
[57] *Ibid.* pp. 21-26.
[58] *Ibid.* pp. 47-48.
[59] *Ibid.* pp. 56-57.
[60] *Ibid.* pp. 76-77.
[61] *Proceedings.* Vol. VI. pp. 157-158.
[61] Information concerning the American Metric Bureau has, in all cases, been gleaned from its official publication, *The Metric Bulletin,* which was published in Boston between 1876 and 1881, sometimes intermittently. The "Bulletin's" page numbering scheme was continued from one month to the next, so that pages 1-96 were those issued in 1876, pages 97-240 indicate "Bulletins" issued in 1877, and so on. The total run of the "Bulletin" makes up only one small volume of 504 pages.
[63] Encyclopedia Britannica. 1910 Edition. Vol. 1; pp. 174-175.
[64] *Who Was Who In America.* Chicago: 1942. p. 319.
[65] *The Metric Bulletin.* (November, 1877). p. 210.
[66] *Ibid.* p. 211.
[67] See *Proceedings* of the American Society of Civil Engineers. Vol. I (November 1873-December 1875). pp. 302 and 321, and Vol. II (December 1876) p. 178.
[68] See *Proceedings* of the American Association for the Advancement of Science. Vol. XXV (1876). pp. 17-31.
[69] "Report on the Metric System." *Journal of the Franklin Institute.* Vol. CI, No. 606 (June, 1876). pp. 370-388.
[70] *Ibid.* p. 378.
[71] *Ibid.* p. 380.
[72] See, for instance, *The Metric Bulletin;* March and April, 1877. p. 128.
[73] *Journal of the Franklin Institute.* June, 1876. p. 380.
[74] Nystrom, John W. *On the French Metric System of Weights and Measures.* Philadelphia: 1876.
[75] *Congressional Record.* U.S. House of Representatives. 45th Cong., 1st Sess. November 6, 1877. p. 256.
[76] The replies, submitted between November, 1877 and May, 1878, were first published as Executive Documents by the House and were later collected in:

U.S. House of Representatives. *Ex. Doc. No. 71;* 45th Cong., 2nd Sess. "Adoption of Metrical System." March, 1878 (Serial 1806).

[77] U.S. House of Representatives. *Ex. Doc. No. 71;* 45th Cong., 2nd Sess. "Adoption of Metrical System." March, 1878 (Serial 1806).

[78] *Ibid.* p. 1.
[79] *Ibid.* p. 13.
[80] *Ibid.* p. 25.

[81] *Ibid.* p. 19.
[82] *Ibid.* pp. 20-24.
[83] *Ibid.* p. 21.
[84] *Ibid.* pp. 21-22.
[85] *Ibid.* p. 23.
[86] House of Representatives. *Report No. 53.* 1879. (Serial 1866).
[87] *Ibid.*
[88] *Ibid.*
[89] See House *Mis. Doc. No. 61;* 1878.
[90] House of Representatives. *Report No. 53.* 1879. (Serial 1866).
[91] The material appended included:

(1) A full set of all papers relating to the Treaty of the Meter, including:

(a) The Treaty
(b) President Grant's transmittal to the Senate requesting ratification of the convention.
(c) Various letters and reports pertaining to the Treaty, including a set of 67 State Department documents.

(2) Copies of all executive department replies to the Nov. 6, 1877, resolution of the House of Representatives calling for opinions on metric adoption.
(3) A letter dated Dec. 9, 1878, from F. A. P. Barnard to C. P. Culver containing his views and recommendations.
(4) An 1877 paper by a Dr. Oldberg concerning the U.S. Marine Hospital Service's adoption of the metric system for medical and pharmaceutical purposes.

This report, as extensive as it already was, was revised, enlarged, and updated 6 months later, in June, 1879, by Congressman Maish and Mr. Culver. It was printed by the House as: *House Report No. 14;* 46th Cong., 1st Sess. (serial 1934); "Part 1 – On the Adoption of the Metric System of Weights and Measures, together with Documents and Statistics Relating to the Subject" and "Part 2 – On Metric Coinage." June 1879 [218 pages].

[92] *House Report No. 53,* p. 19.
[93] *Ibid.* pp. 34-35.
[94] *House Report No. 14.* (June, 1879).
[95] See, for example:

(1) U.S. House of Representatives. *House Mis. Doc. No. 24;* 45th Cong., 2nd Sess. (1878). "The Goloid Dollar."
(2) *House Mis. Doc. No. 8.* 45th Cong., 3rd Sess. (1878). "Theory of the Coin, Coinage, and Monetary System of the World" by J. Meyer.
(3) *House Report No. 14.* (June, 1879) Part 2. "On Metric Coinage."
(4) *House Report No. 203.* 46th Cong., 2nd Sess.; (1880) "Metric Coinage."

[96] Reprinted in *Proceedings* of the American Metrological Society. Vol. II (1879). p. 48.
[97] *Ibid.* Vol. III. pp. 125-131.
[98] U.S. House of Representatives, *House Mis. Doc. No. 29.* 46th Cong., 2nd Sess. "A Decimal System of Weights and Measures for the English-Speaking Nations." (Mar. 5, 1880).
[99] Another proposal along the same lines as that of Col. Sedgwick had been presented to the Committee earlier. This took the form of a letter dated Dec. 2, 1878 from John Arthur Blennerhassett to the Hon. R. M. Knapp. It was printed by the Committee as:

U.S. House of Representatives. *House Report No. 137.* 45th Cong., 3rd Sess. "A New Decimal System of Weights and Measures." Mar. 3, 1879. (Serial 1866).

[100] Hays, Samuel P. *The Response to Industrialism 1885-1914.* Chicago: 1957, p. 143.
[101] *Ibid.* p. 163.
[102] Two recent works, both in paperback, have dealt with the curious subject of pyramidology and most of the subject matter in this subsection has been gleaned from these. They are:

(1) Gardner, Martin. *Fads and Fallacies in the Name of Science.* New York: 1957. pp. 173-185.
(2) Ley, Willy. *Another Look at Atlantis.* New York: 1969. pp. 33-47.

[103] Ley. *Op. Cit.* p. 36.
[104] Gardner. *Op. Cit.* p. 174.
[105] These were:

(1) *Life and Work at the Great Pyramid.* 3 volumes. 1867.
(2) *On the Antiquity of Intellectual Man.* 1868.

[106] Gardner. *Op. Cit.* pp. 176-177.
[107] *Ibid.* p. 177.
[108] *Ibid.* p. 178.
[109] *Ibid.* p. 179.
[110] Cox, Edward F. "The International Institute: First Organized Opposition To the Metric System." *The Ohio Historical Quarterly.* Vol. 68. No. 1. January, 1959. p. 9.
[111] From the cover of the Institute's official publication, *The International Standard,* which appeared between March, 1883 and April, 1888 on a bi-monthly, but sometimes irregular, basis.
[112] Cox. *Op. Cit.* pp. 10-11.
[113] Taken from: *The International Standard.* Vol. V. Memorial Number, (1888). This number is devoted exclusively to an account of the life and works of Charles Latimer.
[114] *Ibid.* p. 37.
[115] *International Standard.* Vol. V, No. 4. (April, 1888). p. 66.
[116] In full:

Latimer, Charles. *The French Metric System, or, The Battle of the Standards.* Chicago: 1880.
[117] *Ibid.* p. 7.
[118] *Ibid.* pp. 8-9.
[119] *The International Standard.* Vol. I, No. 1 (March, 1883). pp. 8-10.
[120] *Ibid.* Vol. I, No. 6 (Jan. 1884). p. 433.
[121] *Ibid.* Vol. IV, No. 1 (Jan. 1887). p. 49.
[122] Totten was also the author of a book entitled *An Important Question in Metrology.* (New York: 1884) and several interpretive papers on the Great Seal of the United States.
[123] "Let Every Saxon Sing." *The International Standard.* Vol. I, No. 6 (Jan. 1884). p. 458.
[124] *The Philadelphia Record.* Nov. 10, 1882 (reported in: *The International Standard,* Vol. I, No. 1 [March, 1833] p. 18).
[125] *The International Standard.* Vol. 1, No. 1 (Mar., 1883) p. 12; Vol. I, No. 6 (Jan. 1884) p. 433; and Vol. IV, No. 1 (Jan. 1887) p. 52.
[126] *Ibid.* Vol. I, No. 1. (Mar. 1883) pp. 63-65.
[127] *Ibid.* Vol. 1, No. 6 (Jan. 1884) p. 439.
[128] *Ibid.* Vol. I, No. 6 (Jan. 1884). title page.
[129] *Ibid.* Vol. III, No. 5 (Jan. 1886) p. 519.
[130] *Ibid.*
[131] *Ibid.* Vol. V, No. 4 (April, 1888). Foreword.
[132] *Ibid.* Vol. V. Memorial Number (1888) pp. 67-68.

CHAPTER V: THE "ENTERING WEDGE" CONTROVERSY (1890-1914)

[1] Morison, Samuel Eliot and Commager, Henry Steele. *The Growth of the American Republic.* New York: 1955. Vol. II. p. 319.
[2] U.S. Treasury Department Office of the Coast and Geodetic Survey. *Report of the Coast and Geodetic Survey for 1889.* Washington: 1889.
[3] U.S. Congress, House of Representatives, Committee on Coinage, Weights, and Measures. *Report No. 795 to Accompany H.R. 7251.* 54th Congress, 1st Session. March 16, 1896. p. 9.

[4] *Ibid.* pp. 9-10.
[5] Morison and Commager. *Op. Cit.* pp. 247-250.
[6] *Ibid.*
[7] Thomen, Harold O. *Checklist of Hearings Before Congressional Committees.* Washington, D.C.: 1959. pp. 107-109.
[8] The full text of this Act is re-printed in: *Science;* New Series, Vol. IV, No. 79; July 3, 1896. pp. 7-8.
[9] *Ibid.* p. 5.
[10] U.S. Treasury Department, Office of the Coast and Geodetic Survey. *Fundamental Standards of Length and Mass* (Appendix No. 6 – Report for 1893). Washington: 1894. pp. 165-172.
[11] *Ibid.* pp. 167-168.
[12] U.S. House of Representatives. *Report No. 795.* p. 4.
[13] Dale, Samuel S. *The Mendenhall Conspiracy to Discredit English Weights and Measures.* 54th Congress, 1st. Session. January 30, 1896. pp. 3-4.
[14] *Science.* Vol. LX, No. 1541. July 11, 1924. pp. 33-34.
[15] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *Hearings Before the Committee on Coinage, Weights, and Measures.* 54th Congress, 1st Session. January 30, 1896. pp. 3-4.
[16] For the basic facts of the British campaign of this period I have relied mainly on the following:

Cox, Edward F. *A History of the Metric System of Weights and Measures, with Emphasis on Campaigns for Its Adoption in Great Britain and the United States Prior to 1914.* (Doctoral Dissertation; Indiana University, 1957) pp. 328-381.

Dr. Cox is not, of course, in any way responsible for my interpretation of the importance of these events on the U.S. campaign.

[17] *The Decimal Association* (Anonymous pamphlet: circa 1898). p. 11.
[18] *Ibid.*
[19] *Ibid.* p. 13.
[20] See, for example, the: *Annual Report of the British Weights and Measures Association;* July, 1905. This document contains a synopsis of John Quincy Adams' 1821 anti-metric arguments and articles by four American opponents, including Frederick Halsey and Samuel Dale.
[21] *Ibid.*
[22] Sullivan, Mark. *Our Times.* Vol. I "The Turn of the Century." New York: 1926. p. 291.
[23] U.S. House of Representatives. *Hearings . . . on H.R. 2758.* January 30, 1896. p. 1.
[24] U.S. House of Representatives. *Report No. 795.* March 16, 1896.
[25] *Ibid.* p. 4.
[26] *Ibid.* p. 12.
[27] *Ibid.* p. 14.
[28] *Ibid.* p. 19.
[29] *Ibid.* pp. 19-20.
[30] *Ibid.* p. 20.
[31] *Science.* New Series Vol. III, No. 69. April 24, 1896. p. 626.
[32] *Congressional Record.* 54th Congress, 1st Session. April 7, 1896. pp. 3688-3699.
[33] *Science.* New Series. Vol. III, No. 69. April 24, 1896. p. 627.
[34] *Dry Goods Economist.* April 18, 1896.
[35] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *Report No. 2885.* 54th Congress, 2nd Session. February 10, 1897.
[36] *Ibid.* p. 2.
[37] *Ibid.*
[38] *Ibid.* pp. 3-7.
[39] *Ibid.* p. 4.
[40] *Ibid.* p. 7.
[41] American Metrological Society, John K. Rees, ed. *The Metric System. Detailed Information as to Laws, Practice, Etc.* New York: 1896.

[42] *Ibid.* pp. 7-8.
[43] Mendenhall, T. C. "Legislation Relating to Standards." *Science,* New Series Vol. IV, No. 79. July 3, 1896. pp. 1-8.
[44] *Ibid.* p. 6.
[45] Mendenhall, T. C. "The Metric System." *Appleton's Popular Science Monthly.* October, 1896. pp. 1-13.
[46] *Ibid.* p. 2.
[47] Colles, George W. "The Metric Versus the Duodecimal System." *Transactions of the American Society of Mechanical Engineers.* Vol. XVMI; December, 1896.
[48] *Ibid.* p. 59.
[49] *Ibid.* pp. 90-93.
[50] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *Report No. 1597.* 55th Congress, 2nd Session. Washington, D.C.: June 20, 1898.
[51] *Ibid.* p. 2.
[52] U.S. Bureau of the Census. *Historical Statistics of the United States, Colonial Times to 1957.* Washington, D.C.: 1960. p. 544.
[53] *Ibid.* p. 550.
[54] U.S. Congress, House of Representatives. *Biographical Directory of the American Congress, 1774-1927.* House Document No. 783, 69th Congress, 2nd Session. Washington: 1928. p. 1229.
[55] *Ibid.* p. 550.
[56] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *Metric System of Weights and Measures. Report No. 3005. 56th Congress, 2nd Session. March 1, 1901.*
[57] *Ibid.* p. 1.
[58] *Ibid.* pp. 2-3.
[59] *Ibid.* p. 2.
[60] Sullivan. *Op. Cit.* Vol. II: "America Finding Herself." pp. 192-193.
[61] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *National Standardizing Bureau: Letter from the Secretary of the Treasury.* House Document No. 625; 56th Congress, 1st Session. April 23, 1900. p. 3.
[62] *Ibid.* p. 1.
[63] Cochrane, Rexmond C. *Measures for Progress.* U.S. National Bureau of Standards, MP 275. Washington: 1966.

A good deal of the material in this section has been drawn from Mr. Cochrane's history of the National Bureau of Standards. Unless other sources are cited specifically, it should be assumed that *Measures for Progress,* particularly Chapters 1 and 2, provided the source of information.

[64] U.S. Congress, House of Representatives. *House Document 625.* p. 3.
[65] *Ibid.*
[66] *Ibid.* p. 1.
[67] Dr. Stratton's biography is contained in: Cochrane, *Op. Cit.* "Appendix M.: Samuel Wesley Stratton." pp. 652-661.
[68] Stratton, S. W. and Rosa, E. B. "The National Bureau of Standards." *Transactions of the American Institute of Electrical Engineers.* Vol. XXIV (1905) pp. 1039-1090.
[69] *Ibid.* pp. 1076-1080.
[70] *Ibid.* pp. 1067-1068.
[71] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *The Metric System of Weights and Measures;* (Hearings on H.R. 2054). 57th Congress, 1st Session. 1902.
[72] *Ibid.* p. 29.
[73] *Ibid.* p. 82.
[74] *Ibid.* p. 13.
[75] *Ibid.* pp. 84-85.
[76] *Ibid.* p. 151.
[77] *Ibid.* pp. 153-154.

[78] *Ibid.* p. 154.
[79] *Ibid.* p. 156.
[80] *Ibid.* pp. 157-158.
[81] *Ibid.* p. 159.
[82] *Ibid.* p. 159.
[83] *Ibid.* pp. 161-162.
[84] *Ibid.* pp. 52-53.
[85] *Ibid.* pp. 65-66.
[86] *Ibid.* p. 109.
[87] *Ibid.* p. 33.
[88] *Ibid.* p. 39.
[89] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *Supplemental Hearing.* "On the Subject of the Metric System of Weights and Measures." 57th Congress, 1st Session. April 24, 1902. p. 8.
[90] *Ibid.* p. 9.
[91] *Ibid.* p. 11.
[92] U.S. Congress, House of Representatives. Committee on Coinage, Weights, and Measures. *The Metric System of Weights and Measures.* Report No. 1701. 57th Congress, 1st Session. April 21, 1902.
[93] *Ibid.* p. 9.
[94] American Metrological Society. *The Metric System.* New York: 1902.
[95] "The Metric System of Weights and Measures." *Journal of the Franklin Institute.* June-July, 1902.
[96] *Ibid.* p. 5.
[97] *Ibid.* p. 6.
[98] *New York Times.* April 2, 1902.
[99] Root Newspaper Association. News item dated October 9, 1902.
[100] *Ibid.*
[101] *Iron Age.* February 3, 1903.
[102] This account of the 1902 ASME meeting has been pulled together from several sources, including:

(1) American Society of Mechanical Engineers. *Transactions of the A.S.M.E.* Vol. XXIV, Nos. 954, 971, 972, 975, 1902. pp. 7-8; 66-70; 397-712; 854-857.
(2) Halsey, Frederick A. *The Metric Fallacy.* New York: 1904.
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[113] *Ibid.* p. 855.
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[115] Halsey, Frederick A. and Dale, Samuel S. *The Metric Fallacy.* New York: 1904.
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[125] *Ibid.* p. 81.

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CHAPTER VI: THE GREAT METRIC CRUSADE (1914-1933)

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[3] Lowrey, Edward G. "The Special Interests—New Style." *Saturday Evening Post.* January 31, 1920. p. 5.
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[7] *Ibid.* p. 220.
[8] *Ibid.* p. 72.
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[10] *Ibid.* p. 61.
[11] *Ibid.* p. 21.
[12] *Ibid.* p. 245.
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[23] See: "Reports of Washington representative of the World Trade Club" (1920) and letters from W. Mortimer Crocker to A. Drury dated 1920-1921. Drury Collection, Columbia University.
[24] *Ibid.*
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[31] A.I.W.M. *Constitution.* pp. 6-7.
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[33] *Dale Correspondence.* Vol. VI.
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[37] Letter from Samuel S. Dale to F. A. Halsey of November 17, 1921. *Dale Correspondence*. Vol. VI.

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[115] *Ibid.* p. 41.

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[57] *Ibid*. p. 27.

[58] U.S. Congress. *Congressional Record—House*. April 30, 1968. p. H3114.

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[60] U.S. Congress. *Congressional Record—House*. June 24, 1968. pp. H5347-H5358.
[61] *Ibid.* p. H5347.
[62] *Ibid.* p. H5349.
[63] *Ibid.*
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[65] *Ibid.* pp. H5357-H5358.

Appendix B

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1. Sources of Unpublished Material

a. Columbia University—two superb collections of unpublished material have been preserved by the Libraries of Columbia University, Rare Books and Manuscripts Division. One is the "Dale Collection," comprising the diary, personal correspondence, collected works and library of Samuel S. Dale of Boston, Massachusetts. The other is the "Drury Collection," comprising the personal papers of Aubrey Drury and the records of the World Trade Club. Both of these collections yielded a great deal of the source material used in the preparation of this volume, and both were particularly valuable in their revelations concerning the personalities engaged in the controversy and the strategies used by both advocates and opponents.

b. The National Archives—The records of the National Bureau of Standards and of the pertinent Congressional Committees involved in the metric system issue are maintained by the National Archives.

c. Massachusetts Institute of Technology—The personal records of Samuel W. Stratton and the records of his tenure as president of MIT are housed in the Institute Archives in Cambridge.

d. National Bureau of Standards—Material of a recent origin (1958-1968) was obtained from the files of the Office of the Director, National Bureau of Standards. Some material dating back to the early 20th century has also been retained by the Office of Weights and Measures, National Bureau of Standards.

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A review of the debate between 1790 and 1968 on the question of whether or not the United States should adopt the metric system of weights and measures. Legislative activities with respect to weights and measures and campaigns for and against adoption of the metric system are reviewed. Significant investigations of the question by both public and private bodies are highlighted. An extensive bibliography is included.

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