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U. S. DEPARTMENT OF COMMERCE/National Bureau of Standards

FOOTWEAR TECHNOLOGY SYMPOSIUM--
Manufacturing a Competitive Advantage

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FOOTWEAR TECHNOLOGY SYMPOSIUM —
MANUFACTURING A COMPETITIVE ADVANTAGE

PREFACE

In response to a directive from President Carter to "provide an expanded and more effective program of assistance" to those segments of the U.S. footwear industry that have been seriously harmed by imports, the Department of Commerce is administering a special program to help revitalize the domestic footwear industry. Several of the Department's agencies are working together to ensure that the Footwear Industry Program will be successful in manufacturing a competitive advantage for the industry.

The Department of Commerce is actively pursuing a variety of approaches for assisting the domestic industry. This effort combines the capabilities and special expertise of the Industry and Trade Administration, the Economic Development Administration, and the Office of Science and Technology. The total effort encompasses a "streamlined" trade adjustment assistance program, an export promotion campaign, a domestic retailer-manufacturer cooperation program, and a new technology utilization program.

This Symposium--Manufacturing a Competitive Advantage-- was one of the critical steps in the Office of Science and Technology's innovative program to create new technologies for the footwear industry. This program is a unique government undertaking to assist a domestic manufacturing industry in that it is

- o the first cooperative government - industry program to develop a new generation of technology in a non-defense industry, and
- o the first government-aided technology development program specifically designed to improve the ability of an American industry to meet foreign competition.

The design for this Symposium was based on three fundamental concepts which underlie all Commerce Department efforts.

- o Full and active cooperation between government and industry. Industry must be relied on to understand the best prospect, key constraints, and necessary market/production interfaces involved in opportunities for assistance. Government must be relied on for the objective analyses, encouragement of creativity, and support which will locate and specify these opportunities.

- Rational analysis of industry problems and structure as a prerequisite for action. It is necessary to involve all segments of the industry; from the retailer who makes buying decisions, through the manufacturing executive who defines market positioning, to the supplier who seeks out new techniques; in a systematic effort to understand industry's problems in their full historical perspective.

- Creative thinking from well-qualified sources outside the industry. There is a need for new ideas on problems, strategies, and solutions. Such innovative thinking must be sought at the leading universities, research institutes, and advanced technology firms in the United States.

The initial steps are taken; the future directions depend on the constructive ideas which emerge from this Symposium.

TABLE OF CONTENTS

ABSTRACT

The Footwear Technology Symposium, hosted by the National Bureau of Standards, was held in Gaithersburg, Maryland on June 1 and 2, 1978. Approximately 220 people participated representing the manufacturing, supplier, and retailing segments of the footwear industry, as well as federal officials concerned with assistance to the industry. The objective of this symposium was to assess manufacturing technologies which could be adapted or developed to provide a competitive advantage for the U.S. footwear industry, and to develop a specific plan for activities that would be appropriate for government and industry cooperation. The meeting was part of a three-year Department of Commerce Program to help restore the growth and vitality of the domestic footwear industry. Initial sessions presented technical and evaluative information as an input to the subsequent working group discussions of footwear industry representatives. Government staff described the results of their assessment of the problems and opportunities of the industry. To stimulate constructive dialogue, five private research organizations presented ideas and recommendations for future footwear technological development resulting from Commerce Department sponsored studies. The major new technologies and processes presented addressed materials development, leather technologies, customfitting and computer assistance in shoe design and manufacture (CAD/CAM). In other presentations, the President of the American Footwear Industry Association shared his concerns, a leading footwear designer explored design, marketing and the technology interfaces, and representatives of technologically advanced industries, (aerospace, automobiles, communications) shared their views on manufacturing technologies and applications to footwear industry problems. Preliminary symposium results were evidence of industry enthusiam and support for government-industry cooperative activities, interest in establishing a footwear center to provide industry-wide technical assistance, and a desire to assess computer-aided design and manufacture(CAD/CAM). Reports by the consulting firms on new technologies and business strategies for the footwear industry are included as appendices.

KEY WORDS: Computer-aided design and manufacture (CAD/CAM); footwear industry; fragmented industries; government-industry cooperation; imports; innovation; leather; materials development; manufacturing technology; shoes; technology transfer.

OPENING REMARKS: THURSDAY, JUNE 1, 1978

Dr. Frank Wolek

Deputy Assistant Secretary for Science and Technology
Department of Commerce

It is my pleasant task to serve as host of this symposium and to welcome you. We are gratified that so many of you from so many organizations in the footwear industry accepted our invitation to jointly explore the special problems and solution of this important U.S. industry - we have almost 220 people from the private and public sectors registered here today.

As the title indicates - Manufacturing a Competitive Advantage - this symposium is concerned with identifying and creating new technologies that will help restore the competitive position of the domestic footwear industry. But this activity is only a part of a broader Department of Commerce program to provide effective assistance to industries seriously hurt by imports. Footwear was the first industry we tackled. Several of the Department's agencies are working together to assist footwear under the leadership of a steering committee headed by Under Secretary Sidney Harman. Although this symposium originated as part of the program of the Office of Science and Technology., its preparation has benefited directly from assistance of the other footwear program components. This includes the Industry and Trade Administration, represented here today by Deputy Assistant Secretary Robert Shepherd. That agency includes the Footwear Industry Team which provides technical and management assistance directly to individual firms affected by imports. Also active is the Economic Development Administration, represented by Deputy Assistant Secretary Harold Williams, which has provided not only funds but also guidance policy on economic assistance.

Appropriately, we are assembled here at the National Bureau of Standards, one of the finest research laboratories in the world. The mission of the Bureau is to provide the information--the infrastructure of analysis, measurements, standards, and basic data--that underlies the contributions of technology to our society. In this symposium we are also presenting to the industry the infrastructure of information that we will all need to determine the development of new technologies to assist your industry during the next several years. Technology is admittedly only one part of the footwear management and strategy, but we here must ask how important that slice is.

What is the future of technology in footwear, and how can we maximize its role both by contributing to the development of new technologies and by assisting with the knowledge needed to effectively implement those technologies?

Three points which characterize our approach to these subjects will recur throughout these two days. The first is analysis. This is a management symposium. Rather than presenting new technical ideas, we are reviewing this industry's problems as a manager might assess them. What are the corporate strategies for coping with those problems, and what technologies contribute to those strategies? That approach must be based on a systematic analysis of existing data on the economic structure and history of the footwear industry.

The second point is creativity. Much of that has already been contributed by the people here. We are adding the ideas of selected outsiders to the industry, some of the best intellects in the research institutes and universities of this country, some of the most creative independent inventors, and representatives from successful firms in other industries that are leaders in the adoption of new technology. Perhaps this information will further stimulate your thinking in footwear.

The third point is cooperation. The decisions to be made here are industry decisions. Our role is to provide the information and assistance that you need to carry out those decisions. The industry must tell us which technologies should be developed and promoted and what is needed for their development.

MANUFACTURING A COMPETITIVE ADVANTAGE

Dr. Jordan Baruch

Assistant Secretary for Science and Technology
Department of Commerce

We are here today as part of an effort to do something. We are here to discuss manufacturing a competitive advantage for the U.S. shoe industry, a long, difficult effort. Why, one might ask, are we trying to do this job? What is so important about the shoe industry? The shoe industry consists of firms, which in turn are combinations of individual people. There is a huge difference between government statistics and plant closings, where real men who have worked all their lives to build a company see their market position destroyed by foreign competition. Government statistics on unemployment are numbers, but the actual people forced out of jobs represent personal economic tragedies.

The United States could, of course, solve the problems of foreign competition and prevent closings, but by building a wall around ourselves, setting up a tariff barrier, and having extensive marketing agreements. Unfortunately, buyers of shoes are also people. Every time we propose new barriers that increase cost we, in fact, tax all members of society in order to protect one segment.

There is one way that we might resolve that dilemma with no cost to society--by making the American shoe industry effectively competitive with foreign suppliers and, thus, insuring the domestic market an adequate share of the growth. As a matter of fact, I would like to see them become effectively competitive to a degree that would pay the high cost of getting there. However, there are many bright people trying to solve these problems and I do not know if we can do better. One thing that I can absolutely guarantee, however, is that we in this Department will certainly try.

The shoe industry cannot depend on border protection alone. It would be a losing gamble. Not only is this administration determined to encourage free trade, but I know that the hidden tarrifs and inflation associated with border protection are well understood now by our fellow Americans, who are not willing to pay them. There are many more shoe buyers than shoe suppliers, and there are a lot more buying states and districts than there are states and districts with shoe manufacturers. Nonetheless, there is an interest in the shoe industry, and we will have some forms of border protection.

We will have other forms of border protection because other countries subsidize their industry and exports and we do have countervailing tariff rules. We will have them to counteract against unfair governmental participation in the competitive act, but not against cheap labor, better management, or economies of scale. The government and the American people want to ensure a fair fight for the shoe industry.

Another interesting choice is to give up. It's the course that some of your peers have already taken. It is an alternative, but as I look at this audience, not one you have accepted.

Clearly, we have one alternative, giving up, that you reject, another border protection, that the government and people seem to reject, and a third one that will require cooperation, brains, money, and luck. We have the capacity for the first two, cooperation and brains, and we know where to get the third, the money. Our efforts today will be designed to minimize the need for luck.

How will we tackle this problem? We are here to discuss the shoe business and the changes that technology can make in the effectiveness of that business. This can be broken down into five tasks.

The first is defining the problem. Where is the problem occurring, why is it occurring, and who is involved? The where is difficult. The shoe business is not homogeneous. Children's shoes are different from women's, salon shoes from men's, and welted shoes from cemented and injection molded. One can also break the shoe industry down into segments: by price, by style, and by the kind of manufacturing process, for example. In each of those cells we can ask, "Where are we hurting from foreign impact, and who's doing the hurting?" One answer is the rational shoe buyer. Thus, we have to identify the buyers that choose to buy foreign, rather than American shoes, and we can segment those too. Lastly, we have to ask, "Why are they buying foreign shoes?"

One problem involved in asking that question is the variety of answers. From the manufacturer, you may get the answer, price. From the buyer, you may get the answer, quality. We get very different answers. We must be aware that groups have their grievances. Buyers want to keep their own channels open through multiple sourcing. Sellers want to accentuate a problem they think the government can solve.

To make progress in this area, we must sort out some of these conflicting data. I hope some of you from the shoe industry will tackle that problem in your work sessions or during the coming weeks.

To design a great solution to the wrong problem is a sure waste of time and money. Therefore, part of today's job is to identify the information we can use.

The second task is to characterize the advantages of the foreign competitor. Is it just cheap labor that they have? Is it economies of scale? Is it marketing? Some foreign companies are using very skilled American-style marketing techniques, and they have invented some of their own. Is their advantage price, and if so, why? Lastly, what are their weaknesses--transport time, the availability of new materials, the ability to maintain complex equipment? If we know their weaknesses and if we have a choice among technologies to help the American shoe industry, we might be able to choose those that are least transferable to foreign countries.

Our third task is to analyze the existing U.S. industry, its management, marketing, and production. There is an interesting characteristic of the U.S. manufacturing industries. There are, on the same continent and using similar materials, industries that are very high in technology and others that are very low in technology. One of the enormous problems is transferring technologies across industries. Rockwell International had a great idea. They had this "high level" electronic organization that decided to go into the printing business. They bought a printing company and a loom company and put in electronics. When those two industries were modernized, Rockwell found the people in the companies did not understand the new way. A major trauma resulted, requiring a major turnover of people. The transfer of technology across industries is difficult. However, I find it exciting that we have representatives here from the automotive, electronics, and aircraft industries who are willing to try to help you.

The next task is designed invention or the development of new technologies that fit the corporate strategies of the footwear manufacturer. Technology and corporate strategy are inseparable. If you're aiming for a market niche of high-style expensive shoes, and all that technology has to offer you is a cost reduction system that operates on mass production, the fit is wrong. Any attempt to measure the potential of a new technology is dependent on the initial analysis of the industry.

Even if we find a good fit, it may still be the wrong scale for an individual company. If a large effort is needed, there are some interesting approaches that we can take, utilizing other parts of the Department. We've been looking at an industry in Providence,Rhode Island which needs some help and may require a consolidation of many small electroplating activities. The individual companies can't do that, but the Department does have access to resources to finance that type of effort by providing aid to the state or city. Thus, we are not ignoring the fifth task, the implementation question, because until we get through with implementation, the new program has not really become part of your corporate structure.

Therefore, our tasks are problem identification, the analysis of our foreign competition, the assessment of our own technologies, the development of technologies fitting the needs and corporate strategies of our firms, and implementation. If we can achieve this, I think we have a good chance of helping the U.S. shoe industry.

GENERAL ACCOUNTING OFFICE PERSPECTIVE

Frederick L. Haynes

Assistant Director, U.S. General Accounting Office

Before discussing the shoe industry, I would like to explain why the General Accounting Office selected this area for review. Some years ago we were involved in a world-wide evaluation of manufacturing technology and its impact on productivity. As a result, we became very concerned that the world situation had sufficiently changed to put the small to medium labor intensive manufacturers in the United States in an adverse competitive position. Coincidentally, the shoe industry, one of those labor intensive industries, was symptomatic of problems occurring as a result of the world-wide spread of industrialization, particularly to those less developed countries which have an obvious comparative labor advantage. Because of this, we decided to take a preliminary look at the shoe industry. Our full report will be out later this year.

I would like to give you a brief overview of our perspective. From what we have seen the less developed nations have been able to uniquely capitalize on their labor wage advantage, government cooperation, and support from Western technologies to the point where their products are competitive with the best industrialized nation products. This situation proposes severe problems and challenges for the innovative capabilities of existing industrialized nations. The United States has a more aggravating problem, having just begun what appears to be a secular decline in our world-wide competitive position. One of the major effects or components of this decline has been the absence of aggressive productivity growth in the United States economy. And of all the industries on which the United States has manufacturing statistics, the shoe industry has exhibited the lowest rate of productivity growth for at least the last 15 years. With that observation one would expect that the shoe industry might not be as strong as we would like.

More specifically, the industry appears to have been caught between the emerging low cost manufacturing capability of the less developed countries, the "high-style" capability in Europe, a changing and highly competitive level of merchandising, and, quite frankly, an unprecedented level of manufacturing complacency. When the shoe industry is usually discussed, the emphasis is on the domestic manufacturing segment. It is, however, more relevant to view this segment in the world-wide context. In this setting, almost every nation in the world has its own capability and each nation's retailers, which are for the most part divorced from manufacturers, select the styles, quantities, and prices for their consumers, from a world-wide inventory. Obviously, other things being equal, the retailers make their purchases from the manufacturers offering the most attractive quality and price. Complicating this situation for the United States is the fact that many large American manufacturers are also large retailers. Here again, even those engaged in manufacturing buy not only from their own captive manufacturing base, but also from the world-wide inventory. While merchandising methods and distribution channels have been tailored to the changing demographic and disposable income patterns, in general, the U.S. domestic manufacturing capability has not kept pace with the technologies which would enable them to be low cost quality producers. However, we all recognize that there are some very forward looking and innovative companies in the industry. Unfortunately, their productivity is insufficient to create a comparative advantage for the entire industry.

Let us look at some of the demographic and disposable income patterns, starting with the consumer and moving back to the manufacturing operation. In our discussions with many of the U.S. manufacturers, we were surprised at their unfamiliarity with the growth and demographic changes and disposable income changes in the United States market. In contrast, manufacturers in Asia and Europe were much more conversive with what was going on in our domestic market than were our own manufacturers. I think that says something about the complacency I mentioned earlier. It is important to recognize that, in the last two decades, there has been a significant shift in the demographic composition of the consumer universe in this country, accompanied by similar shifts in disposable incomes. This can be simply characterized by a pyramid representing the population. The vertical height indicates the age groupings from one year old at the base to 100 years old at the top, and the breadth of the pyramid represents the numbers in each age group. Over the last two decades, there has been a significant shift upwards without a refilling at the base. The base is now smaller and there are bulges which are working into the age groupings which traditionally represent America's buying power. A similar pyramid can be constructed representing disposable income, and a like bulge is again apparent.

The U.S. shoe industry must examine its market as carefully as its overseas competitors do, studying the changing demographic patterns and the effects of disposable income, recognizing that traditionally the greater the amount of disposable income, the greater the propensity to purchase imported goods. A careful look at these patterns in the United States coupled with the technology innovation that we will discuss during this meeting will provide a better understanding of how our shoe industry must be postured and what manufacturers need to do to make domestic products more competitive. American retailers, on the other hand, appear to have anticipated these changes, along with the population movement to suburbia, and began 20 years ago creating merchandising mechanisms and retail outlets to service this specific change in demography and disposable income. This has been repeatedly confirmed not only with footwear people but also those in the general merchandising area.

These merchandising changes will continue. We can recognize this if we just look at the full-service drug stores that sell shoes, drugs, clothes, and fireplace equipment, as well as hardware. About ten years ago these retailers wanted to capture the 10- to 20-year-old market, and then carry and upgrade it through their growth periods. There are similar opportunities for the footwear industry and for America, because the United States market is the greatest, largest, and most profitable market in all the free world, in fact everybody in the world is targeting on your market. Thus, you should at least equip yourself with those tools that others are using, including an understanding of our market--past and future.

There is another trend in the United States which suggests that, as the disposable income increases, there is going to be more and more interest in a world horizon of goods. This means that the manufacturers will be producing a greater variety in fewer quantities for smaller and smaller sectors of the market. They will have to target more precisely in coupling the consumer with the manufacturing base. This suggests some very specific things for your technology, in order to, for example, become more flexible and control your in-process inventory much more effectively than in the past. How are you going to integrate in-process inventory control with your purchasing and with the actual construction of whatever types of shoes you desire?

The United States' technological capabilities and our innovative strength in terms of being able to couple that technology with the shoe industry offers some very unique challenges. Currently, the high cost of new technology makes it more attractive for an average plant to add either a second shift or to work overtime, rather than spend over $4,500 for a new piece of equipment. Instead of looking at an individual machine, the shoe manufacturing industry should be viewed from beginning to end, as a system. That system should be defined and redesigned to produce at competitive world-wide costs. We have in our audience people who have already done this. Today, you have an outstanding opportunity to look ahead at what is available. In fact, today is a unique opportunity not only for the shoe industry, but also for our country. The model we use to solve the shoe industry situation will serve as a precursor for about 165 other industries. How we handle the problem will tell us whether we are going to be able to help the other industries survive the problems now facing you. Thank you.

Questions and Answers

Q: Is there a blind spot among American industries in general in their ability to understand the marketplace:

Haynes: In my opinion, yes. Our country does not have a long-standing tradition for exporting or a need to export. During the industrial revolution, we survived on our own basic resources for so long, we seem to regard our domestic market as ours. We generally fail to recognize that we are emerging into an interdependent world. The world, however, is not looking at our domestic market as ours, but as a part of the world market. This is a cultural problem, but it is a very dangerous blind spot that we Americans appear to have.

Q: What is the importance of mergers and acquisitions in the growth of large companies and are there any differences in the breakdown of times and the flexibility of large versus small companies?

King: According to my understanding of what I have read, you are a large company because you may have 10, 15, or 20 factories. Factory sizes are about the same if you are a small company. In the large companies, there have been some mergers but not many recently because of some antitrust cases 10 to 20 years ago.

As to the change in the times from concept to delivery, of course, you can do it more quickly if you only have five or six employees. The average size of the Italian firm is 17 people. The Italians have been much smaller and more responsive but they are also dealing with a smaller, more responsive supplier industry too. However, in America the order of a small customer to a large material supplier waits until they get enough orders in to justify the run or preparation of that color. Some domestic manufacturers are now greatly condensing that time. They are smaller and considered reasonably innovative. They are out on the West Coast.

Baruch: A lot of design turnaround time, the time that it takes to go from design to something out on the market, does make large companies stiffer, because the set-up cost and set-up times grow. The discussions so far suggest this may be an opportunity not necessarily a problem, because, for example, there are technologies for shortening set-up time.

FITTING TECHNOLOGY INTO THE PICTURE

Margery H. King, Program Manager

NBS Shoe Team
National Bureau of Standards, U.S. Department of Commerce

Good morning. First, let me say what a pleasure it is to see so many of you here. You may have noticed in the agenda that this presentation is entitled, "Fitting Technology into the Picture". That picture, which I am going to describe as briefly and succinctly as possible, was originally drawn for me by a number of individuals whose faces I see before me. Thus, if you discern any errors of either omission or commission, I beg your indulgence and faithfully promise that there will be time for your comments at the end of my talk.

The preceeding two speakers this morning spoke with great eloquence and conviction about both your industry and the potential for technology. I think Dr. Baruch's point about the interrelationship of technology and business strategy is worth reiterating. An old Broadway show tune says, "love and marriage go together like a horse and carriage". So is business strategy and technology an equally interdependent concept. Technology may exist, but can never function within a vacuum.

The Department of Commerce has purchased, for a finite period of time, a number of creative minds to consider both technologies and business strategies for the footwear industry. These considerations have, to a certain extent, been conducted within a vacuum. It will be your job over the next day and a half to remove that vacuum and evaluate all potential technologies within the context of your industry picture.

I said "your" industry picture because one thing I am well aware of, after an intense eight month indoctrination into the footwear industry, is that each of us has a unique picture of the industry. This seems only natural, given our different perspectives. However, we should define that part of the picture which is common to all our perspectives so that we will begin with the same understanding of the environment for technology.

Before addressing that common portion of the picture, let me note that my resources for this picture are many. We visited 14 different manufacturers...from coast to coast...including plants that were on the verge of closing the doors and other operations that were flourishing. We met with the suppliers of both synthetic and natural materials. We also visited with most of the major machinery suppliers. We talked to retailers...the volume operations, the small independents and the department stores. Finally, we sought information from others including trade associations, consultants, resource documents, and academicians.

Our inquiries began with a look at the bottom line: How much does it cost? Although there is no such thing as an "average" shoe, the typical factory cost breakdown is fairly constant. Our investigations indicated these costs to be: materials, 45%; machinery, 4%; direct labor, 25%; and indirect expenses, 26%.

As expected, the largest single cost is production materials. Hidden within this cost is the availability of raw material, the labor rate for finishing and the productivity of manufacturing of the material. Certainly materials is a cost that is amenable to shrinkage through new technologies and better management. The cost element that is perhaps the best known, and most often lamented, is that for direct labor. The production of footwear today follows essentially the same process of a hundred years ago. The only change has been in the development of machinery to duplicate hands. Direct labor costs represent the "hands" which perform between 80 and 240 specific and different operations. The largest percentage...nearly 50%...of the labor costs is in the fitting room.

Machinery costs are only about 4% of factory costs. The obvious 6:1 labor to machinery cost ratio is a vivid indicator of the labor intensiveness of the footwear manufacturing process. In the fitting room, the labor to machinery ratio becomes a mammoth 25:1, clearly supporting what many of you said: "The fitting room is a real problem."

Another way to measure cost is to measure time. With a product that is so closely allied to market demand, one unit of time may be worth multiple units of money. Frequently, we seek and may even mandate technologies that save time. The success of such technology hinges on our ability to quantify and subsequently exploit the saved time.

In measuring time for the footwear production process, we ended up with two pictures-the big and the little. The first is the macro or larger picture of the total process, from design to delivery. To examine this picture, I think it is easiest to begin with the 'hands-on' part, that time when the shoe is actually being worked on. That accounts for about 30 to 90 minutes. However, adding the process time in between each of the 'hands-on' operations, results in a total in-process time of two to five weeks.

In addition, the shoe must also be designed, engineered, materials and parts ordered and received, executive decisions made and the final product delivered. So the full operation from design to delivery may take 10 to 11 months.

Consequently, any reduction of time for an individual 'hands-on' operation is not likely to have any substantial effect on the big picture. It might, however, if we could identify that operation, which, if addressed by the right technology, would have a lever or domino effect on the whole process.

After looking at that 10-11 month process, we decided to examine more closely the design to sample sequence, which takes 3-4 months. In the ordering of parts and materials, cutting of patterns, estimating of costs, conducting of fit trials, and others, there is a great deal of "soft" time...decision making and/or waiting time. There appear to be significant possibilities for improving and condensing this preproduction turnaround time. Again, however, we must identify that lever operation that will enable us to evaluate which technology.

As we began to dig deeper into a definition of the footwear industry, we realized that to look at industry trends we had to look at specific market segments by specific product categories. Footwear is not a neat, clean industry of homogeneous products. We wanted to know the "what's" of your current situation. What market segments have the highest dollar value? What market segments have been hardest hit by imports?

If we divide the market into nine segments, women's shoes and men's shoes account for approximately 80% of the total market value. To chronicle domestic impact on these two markets, we know that in 1966 U.S. manufacturers produced nearly 127 million pairs of men's shoes and 284 million pairs of women's shoes. By 1977, U.S. production of men's shoes had fallen to 103 million while women's had literally plummeted to 141.5 million. In 1977, the net effect was that 57.6% of women's shoes, and 40% of men's shoes consumed by the American public were made off shore.

The general picture is still too gross for definitive analysis. We wanted to see the level of import penetration by price level within specified market segments. In the women's category, 80% of the lowest price level, 37% of the middle price level, and 55% of the top price level were imported shoes. In the case of men's, the relationship between the three price levels, as to degree of importation, was a similar curve although the actual percentages were lower.

Five countries account for 86% of all the imported footwear in the United States, and the source country matches very closely the price levels we were discussing. Taiwan and Korea hit us hard in the low price levels, while Italy, Spain and Brazil have their hardest impact on the top price level.

The points we must remember are that the import share of the lowest price level is greater than the import share of the aggregate market for each market segment. In the middle price level, domestic manufacturers have met the competition with relative success. Finally, in the top price level, the pattern is mixed, but imports still hold the lion's share of the highest value market segments.

Thus, having seen imports grow by more than 100% over the past ten years, do we acknowledge the strength and pervasiveness of the adversary. To complete this examination, we must also look at domestic production and domestic consumption during the same time period. In 1968, domestic production hit an all time high with 642 million pairs of shoes, which was nearly 80% of the shoes consumed in the U.S. By last year that number had fallen to 385 million pairs, which represented only 51% of the total U.S. market--a nearly reverse image of import performance. That rise and fall, although graphic, does not tell the whole story. Another element is the apparent domestic consumption of footwear. In 1968, we consumed 815 million pairs of shoes, while this past year we consumed slightly less than 747 million pairs. But in more critical terms, the average American bought 3.4 pairs of shoes in 1977, but ten years ago he or she bought 4.1 pairs of shoes. This fact strikes me as an anomaly in light of America's increased affluence and the seeming transition of shoes from an item of necessity to an item of luxury influenced by the whims of fashion.

Regardless of that fact, however, the effect of decreased consumption and increased imports has had a marked impact on domestic manufacturers of footwear. In 1967, there were 675 producers of footwear in the United States. By 1975, that number had falled to 378. Similarly, the number of employees in the industry had fallen from 230 thousand to 163 thousand.

Despite these grim figures, some companies have withstood the onslaught better than others. Just as we have maintained our hold on medium-priced footwear, certain segments of domestic manufacturers have remained healthy. Let's look quickly at the number of manufacturers according to annual production figures. The number of firms producing 4 million pairs of shoes, or more, per year, has actually increased from 16 to 21 firms. That's a 37% growth rate. Furthermore, while those 16 firms accounted for 31% of all domestic production in 1967, in 1975 the 21 firms accounted for 50% of all U.S. production. The trends seem to indicate that within this highly disaggregated industry there is a natural evolution towards concentration.

I said earlier that the bottom line was cost, or money, or in this case, profits. Is anybody making money? Looking again at the companies according to yearly production, we find that in the first six months of 1976, those firms producing more than 4 million pairs of shoes showed profits of 8.2% before taxes. As for the other producers, their profits before taxes in the same six month period increased in direct proportion to the production levels. It would appear that profitability is directly related to firm size.

There are some signs of health in this industry. There are some signs of strength. There must, then, be some key factors to the maintenance of that health. We can look at both the competitive process that is generic to the total industry and a few specific management strategies. The key that opens every door is cost, which may make you think of low-priced shoes from the Far East. Let me ask you to think back ten to twelve years. Think back to the first shoes that landed from Italy. They were brought in because they were less expensive and also looked nice. The beginning element to get, if you'll pardon the pun, your foot in the door is cost.

If you can be sure of always having the lowest cost, while still passing the threshold of market acceptance, cost may remain the primary element. As we all know, however, many of the shoes from Italy today are not low in cost. It's cost balanced against value. It's responsiveness, flexibility and creativity. In 1975, footwear was the number one export out of Italy. There are more than 7,000 factories in that country. The supplier industry is equally broad. There is a willingness to take risks, to invest capital, to develop specialized equipment and to change quickly.

Cost and value are only two elements in the competitive process. A third element is marketing. The Far East has been an aggressive marketeer of its products. In many cases, the actual marketeer may be U.S. originated. It has been a successful merger of capital, labor and management skills. Furthermore, we have yet to see what Taiwan and Korea are capable of if they decide to trade off cost for improved value and quality.

Therefore, cost may open the door, but it's not the only element, fortunately. If cost were the sole determinant, things would indeed look very grim for the United States. There are a lot of developing countries left where supplies of cheap labor will be abundant. Perhaps, we must recognize that we may never be able to compete on a cost-only basis. We must continue to strive for cost compression, but we must develop increased strengths in the areas of value and marketing.

We mold and modify these three competitive elements, no matter what our geographic location, through the formation of business strategies...strategies which must be dynamic, not static. Dr. Wolek likes to think of these strategies in the context of the ancient Oriental concept: the Yin and the Yang, which stands for the constantly shifting, but always balancing, positive and negative elements within all beings.

In the case of footwear, it is the equalization, or balancing of cost against value on the scale of market demand. It is the fact that for every action taken with respect to one element, there is a corresponding reaction that will occur within the other element. On some occasions, although we may make no overt change in either element, the market or environment in which we operate may change, thereby skewing the absolute values of the elements. It is a balance that requires both active and reactive strategy on our part.

As we look at cost, we seek means to minimize it. We consider economies of scale through volume production, realizing that it is a risk to go with a limited number of styles. We consider lower overhead through subcontracting specialized tasks, recognizing administrative control of such actions is more difficult. We consider management skills such as humanizing the work force, acknowledging that an improper step could drive up overhead instead of productivity. We consider the efficiency of a unique piece of equipment or process, recognizing the increased possibility of obsolesce. Thus, as we seek technologies to compress costs, they must be evaluated in terms of total impact to business strategy.

What of the other element, value? We seek to maximize this element through numerous strategies. We recognize the value of brand identification although we risk stagnation as market values shift. We may seek to be first with a creative design although there is increased uncertainty of market acceptance. We seek to improve service to our respective retailers, despite the fact that we may be forfeiting certain flexibilities. Or we may seek to create or find a market niche knowing that is maybe of short duration. Again, technologies can be developed to maximize our value, but the success of the technology will depend upon the accompanying business strategy.

From our point of view, a number of domestic producers have been successful in the competition. They have developed strategies which have included such factors as vertical integration, style leadership, product identification, service to retailer, market niche, exploitation of materials, not to mention importation of products to augment and complement their domestic lines. They have successfully balanced the cost and value elements on the market scale.

No matter what your level of business performance, many of you have come to this symposium with two images: one, of your current corporate environment, and second, your particular desires for new technologies. So where does technology fit in the picture? No matter what your perspective, technology fits in two ways. Technology may be considered in and of itself, in that vacuum I mentioned earlier. It may be developed to expand creativity of designs or to increase efficiencies. Furthermore, it may be a revolutionary development of some new product that will cover, protect and beautify our feet.

This is the part of technology that we have tried to bring to this symposium. We have five technology contractors with a lot of ideas including ways to: produce new raw materials from waste; apply computer-aided design; produce fully automated uppers; join leather and fabric through the impregnation of thermoplastics; and assure better fit.

We stand ready to help with the technology. We want to help put U.S. manufacturers back on their feet and consumers back in American-made shoes, but that is not the whole picture. The second, and less obvious way technology fits in is what I have been alluding to throughout this presentation. The technology which we buy today may be available to our competitor tomorrow. What can you buy with a new technology a day ahead of the rest of the world? Perhaps even more germane, what do you buy with a new technology on any day?

For technology to exist is no trick. Scientists are always pushing back the realm of possibility. For technology to function is a little more difficult. It must be integrated into the corporate environment. For technology to provide a preferential benefit, you must be able to exploit it. There must be a market, a public, a consumer demanding the results that technology makes possible.

Thus, to assure the necessary level of exploitation, the technology must be in firm harness with the management of your organization and the marketing of your product.

Knowledge of your organization and your market is what will be needed to evaluate the technologies to be presented. Perhaps your individual picture is crystal clear, with but one blank spot, where you want a technology to "drop in". That is rarely the way it works. The better your understanding of that three-way interdependency between technology, management and marketing, the higher the potential for any technology success.

Where does technology fit into the picture? We hope you'll tell us where it fits into your individual picture tomorrow afternoon.

TECHNOLOGY REVIEWS

CONTRACTORS FOR MANUFACTURING TECHNOLOGIES STUDIES

Arthur D. Little, Incorporated
Battelle-Columbus Laboratories
Illinois Institute of Technology Research Institute
Denver Research Institute
Massachusetts Institute of Technology

Wolek: Seven small studies dealing with new technology for footwear production have been conducted by private organizations. The conclusions and recommendations from these studies were intended to provide stimulating resource material for the Symposium. Five of the studies explore manufacturing technologies explicitly and the other two studies investigate business strategies for improving competitiveness and the utilization of new technology with these strategies.

The specific objectives of the manufacturing technologies studies were:

- to identify current and/or advanced manufacuturing technologies which could have positive impact on the production process,
- to quantitatively evaluate the benefit these technologies could provide domestic manufacturers relative to foreign manufacturers, and
- to identify areas where cooperative efforts between government and industry are appropriate for developing or facilitating the use of improved manufacturing technologies.

These studies were performed by:

- Arthur D. Little, Inc.,
- Battelle-Columbus Laboratories,
- Denver Research Institute,
- Illinois Institute of Technology Research Institute, and
- Massachusetts Institute of Technology Laboratory for Manufacturing and Productivity.

The specific objectives of the business strategies studies were:

- to identify business operating strategies that would enhance the competitive position of the domestic footwear industry, and

- to define conditions necessary for the successful utilization of technological improvements under these business strategies.

These studies were performed by:

- Charles W. O'Connor and Associates, and

- Zinder Energy Management, Inc.

Presentations of the five manufacturing technologies studies follows.

TECHNOLOGY REVIEW-- ARTHUR D. LITTLE, INC.

I'm Robert Bode from Arthur D. Little. We would like to present the findings from our brief investigation of the transfer of technology from four industries to the shoe industry. We examined the technology used in the manufacture of nonwoven fabrics, pulp and paper, electronic circuit boards, and plastics. With me are members of the ADL core team on this program; Louis Ashley, a senior staff member of our Product Technology Section which includes product and process development, materials, and chemistry; and Dick Tschirch, a senior staff member from the same area. I spent nine years in the research division of United Shoe Machinery. That was 21 years ago, but I have had exposure to the industry since then quite a number of times.

We started our investigation by meeting with our ADL technical staff who work in these four indutries. We asked them to describe the technology, and what techniques, materials, or processes could impact from that technology to the shoe industry. To each of these panels were presented a picture of the cost of manufacturing the shoe today. These are the same costs that Margery King discussed earlier. For an average cost shoe, the material is 45%, direct labor 25%, and machinery 4% of total cost. That direct labor cost can be broken down into cutting 12%, fitting 44%, stock fitting 4%, lasting 20%, and soling and finishing 10% each. Our interest therefore was to find, using a transfer of technology, those new approaches which would result in a sizeable reduction in cost. Therefore, we were concentrating our efforts on new approaches which could impact the 45% of materials cost and which could impact the 80% of direct labor. We opted not to concern ourselves with machinery, because of its insignificance.

We judged that in order to impact these costs, the industry should seek the capability of producing a nearly finished shoe upper directly from a semi-processed material. One of the reasons we felt that the research concentration (and the need) should be on the upper was because the use of injection molded unit soles in place of leather bottoms has reduced considerably the cost of that operation. Injection molded unit soles have already captured almost 35% of the bottoming operation today.

We also felt that if at all possible the upper should be a poromeric or porous type material, should be comfortable, exhibiting the proper yielding so that the upper expands on the order of 3% throughout the day matching the variation in foot size. In this way, the problems associated with the Corfam and other existing poromerics would be avoided.

After identifying these concepts of need, we held interviews with two shoe machinery manufacturers. We found that the technology for producing advanced uppers almost directly from a semi-processed material was at the stage where for certain styles a satisfactory product was almost available. As an example we would cite the USM process which produced a polymeric upper close to quality, which we had perceived to be desirable from our in-house discussions. The upper developed using the USM process included stiffeners both in the toe and in the heel.

The USM process is a major breakthrough. However, although it is 90% of the way towards the development of a suitable upper directly from a semi-processed material, additional advances must be made. The next 10% necessary to take the process the rest of the way will probably necessitate an investment of close to 90% of whatever has gone before. In the USM process, the complete upper was made by one shot injection molding of urethane material at very low pressures. The cured urethane was porous because it had an extractable element removed during the reaction.

As previously noted, we concentrated our attention to the problem of shoe upper manufacturing processes and upper materials, hopefully going from the semi-processed material directly to a completed upper. Following are some of the results and conclusions that resulted from our investigations. Mr. Louis Ashley of Arthur D. Little will describe some of the processes which we examined from other technologies and which we felt would be applicable to the shoe industry.

ASHLEY: As previously mentioned, we concentrated our examination of suitable technologies on the following industries: nonwoven fabrics, pulp and paper, electronic circuit board, and plastics fabrication/molding. We identified certain processes and principles, among them those which resulted in poromeric properties, which we felt could be applied to the making of a shoe upper in three dimensions. From the pulp and paper industries we identified processes such as hydraulic needling (a current DuPont process), vacuum deposition for forming substrates on a three-dimensional glass, electrostatic spraying for concentrating and laying the fibers with optimun distribution and dispersion on such a last, and dipping processes (which are currently used in nonwoven pulp and paper industries) for preparing the continuous matrix that would form the shoe upper.

We also examined electronic circuit board manufacturing techniques. Although this latter technology provided little that would be directly applicable to the formation of the uppers, we did find that the detail usually associated with these techniques would be useful in the forming of molds (or at least their finishing surfaces).

From the plastic industries we examined the following techniques: reaction injection molding, liquid injection molding, and high frequency heating techniques; the latter which are already used by industry for joining pieces of the upper. Electron-beam laser holing is a technique that we thought would be useful for making holes in the complete shells that would be part of the upper. Material fibrillation using blowing agents we examined as a way of forming fabrics from a sheet of plastic. This process could be useful for forming substrates. Shrink wrapping is another technique that could be used for forming the finished surface on an upper. The dilatancy principle which utilizes a bag of metal particles to replicate an irregular shape such as a last, could be used to make quick and low cost molds for uppers. This approach was used right after the Second World War for making rather precise copies of feet having orthopedic problems and then making molds for shoes.

The innovative approaches to making complete uppers which we identified were of two major categories. One involved a dip, spray, gel and fuse technique and the other a direct molding process.

For the dip, spray, gel and fuse technique we proposed use of a knitted lining (which would be slipped over the last), or a nonwoven substrate which could be deposited on a screen last by one of the methods previously mentioned. The next step would be to apply powders and any other strengthener required by spraying techniques. The entire composite mass would then be dipped in vinyl plastisol for whatever number of dips would be necessary to build up the thickness required. This plastisol could result in either a porous or nonporous upper. Finally, the outer surface would be molded, perhaps using some of the flow molding techniques that are now being used by the industry.

For the direct molding process, one method would be to mold the complete shoe upper directly on the last (or over a fibrous substrate). A second method would involve the molding of two separate pieces which could then be joined using nonsewing thermal techniques such as dielectrics. In this approach either a bare last or knitted liner could be used, depending upon whether or not you wanted a substrate. Reaction injection molding (RIM) or liquid injection molding techniques are recommended using either polyurethane or vinyl plastisol.

As previously pointed out by Bob Bode these are currently used techniques; USM's technique of molding the upper in three dimensions uses a liquid injection molding with polyurethane. The molds would be low pressure and low cost; they could be made from epoxies, or epoxies plus a metal shell. With the principle of dilatancy approach, mold size would be variable so that the number of molds necessary to provide the range of widths and sizes could be reduced significantly. Substrates useful in this process include three-dimensional nonwoven substrates; either knit socks or fabricated structures made from solid plastic sheets by either fibrillation or slit sheet techniques.

We next looked at the impact of such innovative processes on the shoe industry. It was clear that one of the significant benefits of the direct molded shoe uppers would be the elimination of the cutting, fitting, and lasting room and the pattern making function. Another impact of such a process would be the natural evolution of equipment in soling and heeling which should improve significantly; therefore the cost and the techniques would be improved. Such a process would also permit the automation of proper finishing. These are some of the benefits that we would see emerging out of such a technique.

One other factor would be that a labor intensive process would not become capital intensive. We would expect to see increased productivity from increasing production with a decrease in labor. In terms of cost advantages, we felt that the molded porous upper and the molded bottom would decrease the cost. Although this technology could be licensed abroad, the relative capital intensity of this process would still favor the U.S. domestic industry.

The barrier, however, is obviously a need for development of process equipment. Although 90 percent of the development has been done, in many cases it would take perhaps another 90 percent of the effort to get the last 10 percent of the problems solved. There may also be certain limitations in style that have to be dealt with, although we do not see this as something that cannot be handled. The high capital costs might limit the initial use of such processes to large or rich manufacturers. I also see an overall reluctance of the shoe industry, as in most industries, to accept such innovative approaches.

We looked at ways of getting around some of these barriers and carrying some of these concepts to fruition. We see a cooperative effort that must be made between government and industry. The first two of these are 1) technology development programs that would be aimed towards molded porous shoe uppers and 2) some sort of a financial arrangement for applied research and machine development would also be necessary. The third item is probably another way of going about carrying out the first two; forming a footwear industry institute which would manage these two processes. Talking with shoe machine and shoe manufacturers revealed a high degree of cooperation and expectancy in terms of what one could do if a lot more people became involved. There should be a recommendation for a footwear industry institute which would serve as a repository and disseminator of data in marketing, manufacturing, research and development, as well as sponsor joint technology development programs and applied research activities.

Questions And Answers

Bode: While we answer questions, I would like to just pass around two experimental shoes made by USM using this molding process. They are breathable urethane shoes made from conventional shoe models, the upper thickened at the toe and heel to increase stiffness. It's molded out of metal male molds, spray finished after molding, and has a slab ruled sole and heel added after molding. The shoe is light in weight and has been wear tested for several months. I would like to point out this shoe was made in 1972.

Q: Have you done any marketing work to see whether you could sell that type of product to anybody and, if so, what type of price it would carry?

Bode: No, but since it is a very high quality upper, I personally cannot see why it would not sell as well as anything else.

Comment: I think you are confusing some problems. There are some very satisfactory poromerics on the market, and there have been for several years, which have very good breathability. However, there has been very limited public acceptance just because they are not leather. That's the big strike against them, whether they work or not, is immaterial.

Q: Are you advocating elimination of leather in the manufacturing business?

Bode: No, not at all. What we advocate is to look at every process and every style of shoes to find some sort of proper niche, one which grows as styles change. There are already millions of pairs of footwear sold made out of synthetics.

Q: You are eliminating leather in shoes. Why don't we apply chemistry and do things to leather to eliminate procedures in the fitting room? We have the technology to learn to fit leather shoes efficiently and give the look you want.

Bode: That is definitely another approach. We are not saying here that this is going to replace all leather shoes.

Q: Do you assume that this technology would fit in the low end of the market?

Bode: It would probably be a medium-priced shoe since it doesn't yield throughout the day to exhibit the comfortable fit of a leather shoe. However, we want to be able to introduce that characteristic into the final product by development of a poromeric yieldable material.

Q: What kind of time frame are you looking at for accomplishing the last 10% of the development task?

Bode: We figure it will take a minimum of 3 years. We have not worked out the program yet.

Q: Why did USM stop working on this development?

Bode: If it hadn't been for the antitrust suit against them, USM would probably be spending $20 million a year on shoe machinery research. As any company proceeds, it has only so much funding available, and it has to look at development activities as a commercial activity. USM can't look out today and conduct 5 or 10-year research and development programs as it did at one time. It's looking at a shorter range, because it doesn't have the resources!

Q: What is the status of the patent of the shoe you are passing around the room?

Bode: It was patented by USM in 1972.

TECHNOLOGY REVIEW -- BATTELLE - COLUMBUS LABORATORIES

I am Herb Kleiman from the Battelle - Columbus Laboratories. Gordon Pickett will be talking about some of the technical aspects of our suggestions, but I would like to give some introductory comments. First, we are emphasizing three particular technologies which we think are particularly fertile. Improved adhesive bonding relates to the whole bonding process, particularly synthetics to synthetics, but also the possibility of synthetic to leather, and leather-to-leather bonding -- a wide open field. The bonding area is a major one that relates critically to the industry.

The second technology is leather finishing by the shoe manufacturer, rather than by the tanner. The last one is really several. Waste relates to a number of different possibilities in which mainly the leather wastes can be recycled to come up with a number of benefits which might be very worthwhile.

We tried to develop a few criteria that we think make sense as far as choosing technologies. This is particularly true for bonding, a fundamental area of increasing importance to the industry. It is practically universal because if you could go leather-to-synthetic and leather-to-leather, it becomes almost completely universal. The potential is there, but certainly anywhere you have synthetic-to-synthetic bonding, this technique cited could apply.

Much of what we talked about, particularly in the other two areas, recycling and leather finishing, is important in men's shoes the second largest segment of the industry after women's shoes. It also has been "relatively" successful in fending off imports. I emphasize relative, because its imports are now two out of five while for women's shoes the figure is three out of five. That is better than most of the other segments as far as import penetration.

Basically all three technologies are not affected by the major culprit in the industry, style changes. Therefore, we believe these three make an important target for attack by the industry, in cooperation with the government.

Let me just emphasize one other thing. Bonding is the most fertile area we are going to suggest and also the most universal. There are always problems associated with the bonding process and, thus, many possibilities for adapting new technologies. Here we think there is a potential to do a lot more that simply is not done today. Gordon Pickett will talk about some of the more technical aspects of our presentation.

Pickett: For each of the technologies, I will briefly describe the technology, tell how it might be used in the shoe industry, and try to make an educated guess as to what efforts, how much funding, and finally, how much equipment investment would be required.

The first technology is the improved bonding area. Primarily there are two technologies involved here. One, microwave or dielectric heating can be used to dry the adhesives faster. The second technology is a magnetic induction bonding process which uses specialized adhesives incorporating a magnetic iron oxide, a magnetic induction field, and the capability of generating heat internally in the adhesive. You make a heat seal from the inside out, to avoid damaging the substrate on the outside by trying to get the heat into the bonding area.

Use of these techniques in the shoe industry involves speeding up the bonding process. Microwave could be used to dry adhesive systems, rather than letting them air dry, as is done in many factories today. We can also increase the bonding options. Most bonding today is done synthetic-to-synthetic; however, some of the processes mentioned here offer the potential of going synthetic-to-leather and leather-to-leather.

Finally, the induction process provides a potential for "super bonds". In other words, you could use chemically reactive materials to develop high strength bonds that could replace the stitching and sewing operations.

Both technologies would require adhesive development simply because the adhesives available today are probably not adaptable to either of these processes. In microwave dielectric heating, for example, the materials used in present-day adhesives are not receptive to microwave or dielectric energy and, of course, in the induction bonding area, you would have to develop an off-the-shelf type item for the super bond. In the induction bonding area also, there is some question as to how to best implement this technology into the shoe manufacturing process. Once the shoe manufacturing process has been studied to determine how induction bonding might be best utilized, coil design should be optimized so that the magnetic field can be applied in the most effective manner.

Equipment costs for microwave or dielectric heating will range anywhere from $25,000 to $100,000, depending on the size and complexity of the production lines. The induction generators used in the induction bonding process are commercial entities. They cost about $50,000, but are capable of operating multiple lines.

The second area I would like to cover is leather finishing by the shoe manufacturer. This primarily relates to the application of color, abrasion, and other finishes that are normally used on leather.

Possible systems include present finishing systems as done by the tannery today or the use of high technology materials, such as ultraviolet or electron beam cure systems. The finishing might be done at the input stages, when the leather comes into the factory. Here you would save the damage done to the finishes during shipping. However, the biggest savings seems to be in the finishing of the final product, the shoe. In other words, you would work with the crust leather, go through the entire shoe manufacturing process, and then after the sole is attached, or at some intermediate point near there, apply the finishing materials. This offers the advantage of saving coating materials presently being thrown out during cutting and trimming operations.

One of the key areas that needs to be considered here is the attitude of the tanners. I doubt they would be receptive to the shoe manufacturer taking over this process.

Secondly, we need to determine what sort of economics can really be achieved. We could not get detailed information on how much the finishing costs impact the total price of the shoe. Regarding the research and development efforts that are required, use of present finishing systems just necessitates a technology transfer from the tanning operation into the shoe manufacturing operation. However, application of the high technology systems would require a materials development program because presently-available materials are not directed to the shoe industry, and shoe finishes have certain characteristics that these materials do not provide in their present form.

Equipment required would be highly variable depending on the options chosen. The use of the present solvent- or water-dilutable finishing systems, hot air dryers and associated spray equipment, for example, might cost around $50,000. However, in the high technology system, an electron beam curing unit alone can run up to $250,000.

The final area to discuss is the recycling of leather waste. Some leather waste is now used to make inserts for heels, belts, and leather-trimmed articles. One emerging technology uses cryogenics and hammermilling techniques to grind up the leather wastes into a fibrous form which can then be processed into other articles. One concept being developed at Battelle involves a further processing of the hammermilled waste materials if you want shorter fibers or a powdered leather material.

Once the leather waste is reprocessed, then comes the question of what can be done with it. First of all, it could be dispersed in water and deposited on a screen form to make a finished product. In other words, if you had a last made out of a screen and put a vacuum on the inside of that, you could deposit the fibers and actually make a shoe upper. Shoe insoles could also be made by this same technique. You might produce a continuous web of the material such as is done in the paper industry operations. That might serve as a base for synthetic materials to replace the present cloth backing materials. You might take the dry fibers and deposit them electrostatically on a last to make a shoe of them. You might also, at the same point in the process deposit powdered resins, perhaps also electrostatically, to bind fibers together or to apply a finish coat. Incorporating very short fibers or maybe even a powder into the coating used to finish the shoes would impart breathability and other characteristics unique to leather. The waste fibers might also be made into a leather cloth. Thread spun from the small fibers might in turn, be woven into a cloth. This again could be used as an integral part of the shoe itself or as a base for the synthetic.

Primarily, we need to determine what type of new product and end use possibilities for the wastes would be made available. These new opportunities would not necessarily be limited to the shoe industry. Determination of these end use products will dictate the recycled form needed and that in turn suggests the processing needed.

Of the three areas discussed, this technology requires much higher risk. As an emerging technology, much more development is required. We estimate several hundreds of thousands of dollars probably would be needed to develop the whole range of possibilities. However, it also offers a large potential payoff, because since 45% of the shoe cost is in the materials area, recovery of part of this expensive raw material would represent a definite economic gain. Finally, it is difficult to estimate the equipment required because there are many options here.

Concerning the impact of some of these technologies, the largest payoff we think is in the bonding area, which applies across the whole shoe product line. The long-term opportunity is the recycling area, where economic gain is recovered from a high cost raw material, but this is also the most risky area. The least demanding research and development efforts will be in the finishing and bonding areas. These are presently available technologies, which just need to be adapted by the shoe manufacturer. Conversely, the most demanding or most costly is the recycling area.

Questions And Answers

Q: Have you actually tried the adhesive with the iron oxide powder you mentioned under the induction bonding? If so, is it of commercial quality?

Pickett: Yes, we have used it. Here are some bonded strips here that you can evaluate. However, its value depends on its use. If you use it to replace stitching, I am not sure it is the best quality. However, the curing time is essentially instantaneous. The bond is formed in a matter of seconds. It is only a fraction of a second in the coil but since you have a heat seal, the pressure must be maintained for a second, while it cools.

Q: Don't microwaves and dielectric heating dry the basic product itself as much as the bond?

Pickett: It depends on the moisture content. Most of these are self limiting. For example, dielectric will cut off at about six percent moisture content. In other words, below six or eight percent in a dielectric field, it does not heat up. If you get above that, it does.

TECHNOLOGY REVIEW -- ILLINOIS INSTITUTE
OF TECHNOLGY RESEARCH INSTITUTE

Good morning. I am Jack Williams from the Manufacturing Productivity Center of the Illinois Institute of Technology Research Institute. We are a non-profit organization, engaged in the applied research of all the engineering disciplines, plastics, composites, electronics, computer sciences, and numerous others.

We have recently been involved in the area of technology transfer, particularly innovative technology transfer. As a result, we have learned never to start developing or designing a product without first looking at what is already available in some other field that might, by minor innovation, be used to evolve the new product.

We visited seven midwestern shoe manufacturing plants and one tannery. Using those seven plants, we developed a profile of a plant that has 350 employees, producing a million pairs of men's and women's footwear a year. It would be one of two plants owned by a single company. In addition to this composite profile there is a listing of composite findings that were common across all seven on those plants. I will mention just one. Eighty percent of the product life span in a shoe manufacturer's plant is spent with nothing happening to it. It is standing and waiting to be moved or worked on or it is being moved. Less than 20 percent of its life span in the plant actually involves being worked on. That creates significant in-process inventory problems.

Today, it is technically possible to build a totally automatic factory today, but it is not economically justifiable to do it. In time it may be. However, there are many opportunities in the shoe industry for the long-range development of high technology. I will talk about a few of them at the conclusion of this presentation, but the general thrust of our study is the turnaround right now in the shoe industry. Business cannot presently afford to enter long-range high technology efforts without getting some immediate quick turnaround to keep them alive.

I want to discuss four areas, and please forgive me if my language does not agree with that of the shoe industry. The four areas are the incentive pay system of the shop floor reporting for production information; technology in the area of joining of components, whether leather or man-made materials; marking of components; and the entire process of grading, pattern layout, and cutting of the leather.

Let's talk first about shop floor reporting, I refer to the ticket pulling operation used throughout the industries. We spent quite a significant time monitoring lost product hours from this operation and found, on an average of those seven plants we looked at, a cost of $40,000 a year of direct labor time. This does not include the time of the shop foreman or that of the time clerk who accumulates and totals all that information. In the end, you have nothing of any use to you other than the payroll. A simple technology to solve this problem is bar coding. It is simple, well proven, well established, and easy to move. If you put a bar code tag preparation device which is nothing more than a simple typewriter device, at the beginning of your plant where the pallets or carts are assembled you could put a bar code on there which would identify that pallet and what is on it. A bar code reader at the exit of each work station would result in an immediate accumulation of who did the work, what they did, what operations were performed, what products were on that cart, what status of production they are in, and what was the reduction in inventory as a result of that pallet passing there. All that information would be available by pushing the cart past the reader. We visualize 30 readers and one type preparation device, costing about $45,000, a small mini-computer for about $25,000, and about $10,000 worth of insignificant software, giving you a total investment cost to install of $80,000. Assuming that you get back only 90% of the time that worker spends pulling tickets, you are still going to save $36,000 a year, giving you a payoff in 2.2 years in direct labor cost.

Next, I will discuss the component joining area, including leather stitching and both leather and man-made cementing. I have little to say about cementing except for the area of high frequency heating. Microwaves have proven to be very energy efficient and a low cost, quick method of achieving heat, particularly when compared to some methods presently used in the shoe plants we visited. It would be very easy for shoe manufacturers to obtain such devices and use them in lieu of the current methods of creating heat for cementing operations, and would be a significant savings.

Concerning leather stitching, at the seven plants we looked at the average cost of sewing was 27 cents of direct labor time per pair of footwear. Using a one million production figure per year, that yields a cost of $270,000 annually for stitching and sewing. A number of things can be done about this: liquid stitch plastic thread, and impregnated leather.

Liquid stitch was developed about four years ago at a cost of about $25,000 of internal research and development funds at our research institute. Four perforator needles are backed up by four injector needles. It does not have to be four. The needles come down and punch holes in the material, it moves out of the way and the injectors drop down into the same holes and inject a thermoplastic material. We used a nylon material which eventually worked fairly well. It keeps moving down the stitch line in that fashion. I would strongly recommend it only for straight line sewing of the kind found in the long zippers on the side of boots. That kind of an operation would profit from this kind of technology. Strength tests of the thread and the nylon liquid stitch were absolutely comparable.

Plastic thread was developed to solve the problems resulting when bobbins run out of thread. In this process normal thread is coated with a thermoplastic material and used to sew with a chain stitch, rather than a lock stitch, eliminating the bobbin. Normally, if you break that chain stitch, it will pull out. However, if a small ultrasonic sewing head is placed behind the sewing head, every place that thread goes through and comes in contact with itself, that thermoplastic material on the surface will fuse together. It is a very simple solution to what must be a very trying problem.

The third idea is really the only one that is yet untested. Our chemists and chemical engineers, all say there is no reason one cannot impregnate leather with thermoplastic materials and adjust the thermoplastic material so you do not have any effect on the textures or quality of the leather. It may discolor slightly, but it will be dyed eventually anyway. Fundamentally, the idea is to take two pieces of thermoplastically impregnated material, put them together, and simply ultrasonically heat them. The thermoplastics in that material will fuse together and produce a very good liquid seal. It is not a thread, but where you only want a good solid joint, it seems to be a good application.

For these methods of component joining, the average payback period is about 2.5 years. The exception, impregnated leather, will run 2 to 3¼ years before that investment is paid back.

The next subject, the marking of components and shoes, is an expensive area in those seven plants we visited. This includes the alphanumeric characters that are permanently applied to the shoes, the identification marking of component parts as they move through the shop, the stitch marks and join or match marks on components to guide the assembly. Those three areas of marking cost about five cents a pair. That is $50,000 a year for a million pairs of shoes. A marker could be built right into the cutting die so that as the component part is cut out, it is marked with the necessary stitch mark or match mark. The cutting die will cost more but in the end the savings more than pay for it. By doing it in one operation, you are actually eliminating two or three operations now done singularly.

Alphanumerics is more difficult, but perhaps a fairly common device, the impact matrix type printing head could be used. Fundamentally, this is a block of little metal sticks with an impact movement to it and an alphanumeric character located on the end of it. Interconnected to a typewriter keyboard, it can be operated directly by keyboard or by punch card input. Following a command for a letter, the block moves up to put that letter in line with and properly spaced from the previous letter. A system such as this could be readily installed in a normal punch press or a press kind of operation where you could bring the head in contact with the shoe, feed the card in, and simply go ahead and run the identification number in the shoe. This could be achieved with a much higher speed than is currently available.

The system would cost $50,000 to put in place. The payback is actually $44,000 a year, but cutting dies will cost at least $25,000 a year more. Thus, putting that marker in the die is going to reduce the annual payback to $19,000, resulting in a payoff of 2.6 years.

The driving force in the next area, grading, nesting and cutting, is the high cost of material. Why do materials run from 40 to 50 percent of the cost of the shoe? The primary reason is poor utilization resulting in excess scrap. The grading of the raw leather itself is done manually and not always consistently. I think you would gain efficiency by going to an automated process for grading.

The second element that drives up that cost is material waste due to pattern layout. Once the useable portions of that leather have been identified and graded, the pattern layout, also done manually, does not provide the best layout of patterns for optimum use of material. Even if the pattern layout is done properly, the third element, inaccurate cutting, leads to further material loss.

Let us see what a grading system could look like. Once a hide is chosen and locating holes and an identification number are put on it, it could be scanned with a sensing array of photosensitive cells. These are basically photo cells that read reflectivity. You could scan the hide with that light-sensitive array and read the surface reflectivity in order to identify the "map" of the portion of the hide with the appropriate surface finish. The next step is to look at the texture, a factor of thickness and density. By penetrating the hide with airborne sound waves, the thickness and the density of the material could be determined. This density map would be overlaid on the reflectivity map and stored in a computer for future use.

After this rawhide grading, the computer can be used to determine optimum pattern layout. The die cutters are identified with particular textures and surface finishes of the material. This information is put into the computer which then selects the best location and orientation for each die on a given hide. It will store this information in terms of where the die cutter is and what its orientation is according to its center location. Center location is important because a center post should be put on each die to give the subsequent cutting operation something to grasp. The hide can be mounted on a pallet which is put on a machine. A rotating drum contains up to 64 tools, brings the proper tool to bear at the appropriate location, and punches whatever is needed. The machine moves at 1,500 inches a minute between hits and is capable of hitting well over 200 hits a minute, yielding a high production rate. At this stage, all the operator needs to do is to identify the number of the hide presently on the table. The system would then go back in its memory, recall up the map of that hide, the pattern layout, and the necessary tools to punch it, hold those tools up in the right locations, and punch out the parts, simultaneously giving you the marking operation if you use the marking die built into the cutting die.

This system would cost $550,000 to put it in place, and the payoff would be $225,000 a year. It is still a very large initial investment. My suggestion is to move it back to the tannery, which has many customers and has the large volumes needed to justify that kind of investment.

Now I would like to talk briefly about other areas susceptible to long-range technology. One is group technology which is based on the similarities between parts that require the same processes. This can yield a data base of parts which a designer can use when considering a new shoe. If he designs a new component part, he simply puts a coding and classification number on it that describes the attributes of that component and checks his system for similar parts. If there are any, he has precluded the need to redesign. He also has all the necessary production data, tool identification, and tool locations to produce the component part.

Robots could serve the shoe industry well. They can be used to read bar code labels on shoe last and return that shoe last to its proper location by reading the size and style number. Other areas are discussed in our report. That concludes the presentation. Thank you very much.

TECHNOLOGY REVIEW -- DENVER RESEARCH INSTITUTE

I am James Kottenstette and I want to discuss the idea of bringing custom-fitting to conventional footwear. I would like to first bring three ideas together that we fould deeply troubling when we undertook this work. First, we found, for example, that people often talked about the need to lengthen the manufacturing run. Next, we encountered bits of information about people with general shoe fit problems not special fit problems. Third was the need for our concepts of technology to produce, we thought, greater demand for American manufactured shoes. During our initial discussions someone raised the possibility of custom fitting shoes at the retail point of sale. A custom fit concept would be an innovation in footwear manufacture and retailing, designed finally to increase the demand for American-made shoes. It would have to be done in such a way as to limit the international transferability of the technologies involved while ensuring broad access for American industries to the technology. Perhaps the relationship between the retailer and the manufacturer would also be strengthened as part of this process.

The stimulus for the idea in part came from the fact that ski boots are custom fitted at the point of retail sales. We felt that insert materials could be added to the lining of the shoe upper and/or to the insole in such a way that the insert becomes an integral part of the shoe after the fit is assured. Three different approaches could be used to achieve this custom fit in ski boots. The first, called Flow Pack, is a material that will deform under foot pressure and essentially conform to the inside of the boot shell and to the skier's foot. The second material could be inserted and uses polyurethane or a thermo-setting wax, formed into a blotter with essentially the same results. Lastly, a material called memory foam is essentially shaped by custom cutting and adding the material to the liner in the boot, thereby delivering the fit.

Using one or more of these methods the retailer might be able to offer custom fit footwear from a smaller size width inventory. If they choose not to reduce the inventory, they might increase the number of styles available for the consumer to select from. The manufacturers could produce more shoes in a single size-width shell and, as a result, have a longer style run. All of this will work only if in the end the customer is enjoying greater satisfaction from the custom fit.

Kottenstette: That is an important point. The problem is that the use of current insert materials creates a closed surface. There are, however, at least potential materials that have a desirable absorption, flexibility, and that can be put in a matrix form and essentially stabilized.

Q: What about reliability when a shoe is worn more frequently than a ski boot?

Kottenstette: This is where a cooperative effort between industry and government to develop materials that have the right characteristics could develop. I expect there is little data on how well the boots do hold up. I think the secret might depend on whether or not one could actually make the insert material an integral part of the shoe.

Q: Is there a capital investment requirement by the retailer to accomplish this?

Kottenstette: There is some amount, perhaps an investment in the fitting socks and a stabilizing device such as a microwave oven.

Comment: One suspects that there is a market niche of those people who have difficulty getting fitted, and we must avoid cutting off ideas too soon. If we are going to increase shoe industry progress, we must look not only at overall solutions but also suggestions that do satisfy some sort of a market niche.

Kottenstette: I can only see this working from the point of view of retailers who see it to their competitive advantage to be able to advertize that they are delivering custom fit in addition to their service, their styles, and the brands that might be there. As far as time is concerned, I have heard stories from women who spend one half hour to an hour and a half trying to get fitted in a pair of shoes. Sometimes they also have some custom fitting, for example, lifts are often used in fitting women's shoes. We already have a market response from people who have a problem in getting fit. Therefore, when we can do this at a profit, we might find a modest shift in the number of American shoes as a percentage of all shoes sold in this country. I would like to see it go to 55 percent.

Comment: If an importer wants to bring in shoes which can also be used this way, he will do it.

Kottenstette: I recognize the truth behind this, but patent protection can be established for the insert.

Comment: We are talking about the realities of it. By protecting the development of these materials and the standard systems that deliver the insert in an integral fashion, you will put your competition off for several years, but if it is a good idea, they will build their own system.

Kottenstette: My point is this is the one technology we would refuse to export.

Comment: This would not be in the public domain; it would be developed jointly by government and the footwear industry. The licensing could be very carefully restricted on the use of this. One of the interesting things about patent licensing and sale of patented goods is that the manufacturer could restrict its use. Therefore, if the manufacturer were making shoes under the licensing for this kind of insert, it would be illegal to import other shoes to be used for the same kind of thing. Those are enforceable restrictions. It is the kind of barrier allowed in the European Community Treaty.

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TECHNOLOGY REVIEW -- MASSACHUSETTS INSTITUTE OF TECHNOLOGY

I am Dr. Frans Van Dyck, Assistant Director of MIT's Laboratory for Manufacturing and Productivity. Our presentation today is divided into four sections. First, we have developed evaluation criteria for judging technologies. To do this, we visited 18 organizations including 8 footwear manufacturers, a die manufacturer, a last manufacturer, retailers, tanneries, and trade associations. The second part of the talk will deal with technologies with short-term benefits. The third one concerns technologies and research offering long-term benefits which might make the United States a leader in footwear. Fourth, we will discuss the development of a cooperative research program.

We have five basic criteria with which to evaluate footwear manufacturing technologies. The first one is the effect of the technology on the product cost. The second is the effect of the new manufacturing technology on the style reaction time. The third one is the quality of materials in stitches and their effect on the quality of the product. The fourth one is the effect of the technology on style perception and style inventiveness. The last criterion is the anticipated time lag between the implementation of the new technology or the decision to implement it and the moment we sense its effect on the market. This criterion has been used here to subdivide the technologies into those with short-term and long-term benefits.

Not one single technology can solve all the problems by itself. There has to be research done in many different fields. On the short term, a lot can be done in savings of materials, perhaps by giving better equipment to the cutter. If he were given a larger table, equipped, for instance, with a system that projects a well-nested pattern on it, he would be able to shift a piece of leather for maximizing the number of flaws in the waste and for maximizing his materials utilization. This might decrease productivity because it will take him more time to do that search. However, the table is large enough to cut simultaneously, so we could consider new equipment to use for simultaneous cutting. Roller die cutting, rolling a big cylinder over a set of dies, gives a significant reduction of the total cutting force, yet your local concentration of force can be high if you also adapt the design of the dies. We might need a leading and a following roller so the dies stay where they are placed.

A second, short-term effort is the use of appropriate on-the-spot materials testing in the plant. After lasting bursts may occur in the upper. This can be solved by very simple testing techniques. A lot of work has been invested in that part when it goes to the lasting machine, so if we can prevent such things by proper testing, we can save a lot of productivity and waste.

The third thing we have investigated is the use of manufacturing axiomatics, a new way of looking at manufacturing processes. In the Laboratory for Manufacturing Productivity, we are investigating whether axioms exist which govern the productivity of manufacturing operations.

One of these axioms is to minimize the information content. The information content of manufacturing is the amount of descriptions necessary to describe a complete manufacturing process. A consequence of this axiom would be to try to combine as many operations as possible, but at the same time making sure that each of the functional requirements of the manufacturing process can still be satisfied independently. For example, why can't one operator do both sole trimming and heel trimming. Very often in factories it is a different operator and a different machine. Every time an operator picks up a part and examines it, he gathers information which is lost when he lays it down again.

On the longer term we have been looking especially at the use of computers, new processes, and new materials. The whole problem of reaction time was discussed today. How much time does it take before a new style can come on the market and can be manufactured? Computer-aided designing and computer-aided manufacturing, increasingly used in the metal working industry, might be of great help. First of all, we must be able to introduce the whole complex geometry of a last into a computer. We might then come up with computer-aided manufacturing systems for making the lasts. Model lasts, made out of hardwood with reinforcements at the edges will not be needed anymore when we work with the computer. Fewer lasts would be needed if we can find ways to optimize the memory storage of the whole geometry of the last. The same system can be used, for instance, by a designer fitting patterns around soft model lasts. He could put the three dimensions of his parts into the computer. The computer can be used later to develop the three dimensions in two dimensions and then to do the grading. The computer system could also immediately put out on paper tapes,on magnetic tapes or on disks which would drive the last manufacturing system, the die manufacturing system and computer-controlled stitchers.

Another way of quickly putting three-dimensional information from the design process into the computer would be to use a sensitive last. It would be a last filled with wires and interfaced to the computer. When we activate one of the sensitive points, it would be immediately stored in the computer and could be shown on a video screen. With this three dimensional information in the computer, we can do grading or get computer output to drive an automatic die manufacturing machine, cutting machine, or last manufacturing machine. Here is a videotape on work done at MIT as an example of what could be done in this whole design process by computer graphics. By representing data on tape, cassette, or disk, and giving a presentation on the cathode ray tube, we can edit very quickly whatever errors might be on that tape. This whole system was developed by MIT's Professor Dave Gossard, an expert in computer graphics. He would be one of the people on the team that would develop such systems for the footwear industry.

The cost of such systems has dropped tremendously the last five years. It would have been completely uneconomical for the footwear industry five or ten years ago.

Professor Gossard is involved in another project at the Laboratory for Manufacturing and Productivity. It is a system for computer-controlled bending. At a cutting die manufacturer there is a lot of work involved in the bending of cutting dies. After every bend the operator has to check his part with a model or a drawing, perhaps several times. This machine would allow us to put data from the computer-aided design systems into a computer-aided manufacturing system to obtain properly bent dies. This would shorten the whole process of manufacturing dies significantly, possibly resulting in cost savings also.

Simultaneously, we have to do research in processes, because computers by themselves are not going to solve all the problems. We need new ideas, for instance, for stitching. Now the problem of stitching of leather is that the penetration force for a needle through leather, and the flexibility are all high, making the stitching operation difficult to execute. We have some ideas on reducing that force.

New ways of stitching might be developed. One example is the use of a consumable needle with a thread through it. It would show us a thread as a normal stitch and would still have the flexibility of a stitch, but on the other side would be rivets.

Materials is another area of research. There is a large amount of raw materials from the United States exported to other countries, including Japan, Mexico, Korea, Rumania, and the Soviet

Union. Twenty-one million hides, 50 percent of the production, are exported annually to these other countries from the United States. We should try to use this resource more efficiently in this country. Research is needed to improve the quality of the raw materials through automatic detection of flaws, as is research on recycling materials. This has to go together with research on computers and on processes.

The fourth part of my presentation deals with cooperative research. How could we work together to get some of these technologies into practice? By itself, an institution like MIT cannot do the kind of research most useful for industry. It is impossible because we need a very close working relationship between the companies and MIT. On the other hand, if you take the companies themselves, there is not one company that can do the needed research. Few have the capital to do the research, we must establish a close working relationship among industries research centers, and government. Presently at MIT there is such a program on polymer processing. More than 20 researchers are involved, and funding comes from 12 major U.S. companies. It was begun with support from the National Science Foundation. A similar program could be very beneficial to the footwear industry. If it does not happen in this country, it will elsewhere so we must do it to remain competitive. Government, industry, and major research organizations should all be involved. Thank you.

Questions And Answers

Q: What is the present day cost of a computer that can scan a hide and decide where to put the pattern?

Van Dyck: I do not know the exact figure, but I know about return on investment. A system under development is expecting a return on investment of two and a half years.

THE POTENTIAL OF NEW TECHNOLOGY

Frank Daley

Director of Manufacturing Development
General Motors Corporation

In early April, when I told my wife that I had received a call asking me to participate in this footwear technology symposium, she said, "Why should somebody from the car business be helping the competition?" That just about floored me. I do hope that I can contribute effectively today, but I must admit to some prejudice in saying that I consider wheels a preferred mode of transportation.

My particular experience has been in designing automobiles and in developing the manufacturing technology to produce them better. My only hint of qualifications in footwear is that my grandfather learned his first trade as a shoemaker. I remember well the tools of his trade that occupied a favorite corner of his workshop.

Remembering those tools makes me think of how in many areas of the manufacturing industry we tend to become static in our approach to production technology. In much the same way in my business, we have stuck with the tried and true and sometimes have been slow to realize how rapidly new technology is developing all around us, and the opportunities it can offer.

This is a time of great opportunities as well as great challenges. In 1973, the automobile industry in the United States was dealt a sudden sobering blow -- the oil embargo dropped on us at a time when complex product decisions relating to regulatory requirements were already straining our capabilities -- things looked dark.

Today, I plan to tell you how new technology and a lot of other resources were applied to help our industry recover from that setback.

Since that time, General Motors' 1978 automobiles have attained an improvement in fleet average fuel economy of 58% by reason of tremendously improved designs. We have been able to produce products that fully meet greatly changed demands of the consumer and the government...and I'm pleased to report sales are great.

In 1973, the decision to redesign our cars to smaller and lighter vehicles was already made. This Corporate project was a massive effort and was accomplished in record time with the help of the computer technology. Computer aided design -- CAD -- has proven itself at General Motors. Thousands of man-hours are saved by being able to take profile measurements electronically, directly from design models, and have the computer prepare precise "blueprints". Skilled designers and draftsmen can then revise and refine drawings on a graphic design console which resembles a TV monitor. They simply "talk" to the computer with an electronic stylus by "writing" on the screen. Line smoothing and surface blending as well as other finishing details can be done in literally seconds. Another time-saving benefit is that the computer system allows designers and engineers miles apart to access the same information and make their contributions.

The result of our first downsize project were unveiled with our 1977 full-size models which were several hundred pounds lighter yet interior roominess and passenger comfort were preserved.

Our goals were accomplished without the use of radical new structures or expensive new materials. We made a big first step with our first cycle of creating smaller, more efficient, automobiles.

Meeting the 1985 fuel economy requirements will require another strong dose of technology to advance our use of lightweight structures and materials which will continue to satisfy our customers as well as meet government standards.

In doing my homework on the footwear industry, I find that we both depend on three major inputs to make our product: Style and design...suitable materials...and the manufacturing technology that puts them together and sends them to market. I will leave the first item to those who are better qualified to sense market and design needs, and focus my attention on the second and third items...and the promise that they offer.

You might be interested to know that I took a recent lesson from the footwear business. About five years ago, as my activity looked to the future, we judged that some form of resilient bumper system or header panels might be highly desirable in automotive products. We learned that polyurethane was being used in Europe to make footwear, especially ski boots, by a process called Reaction Injection Modling -- RIM. This process offered the potential of making plastic parts in a machine which could operate at considerably lower pressures than those required for conventional injection molding. This kind of system, scaled up to a much larger size and fully automated, could let us make flexible, tough, lightweight parts competitive in cost with conventional materials. Polyurethane components from this complex program are currently in successful production and used on approximately 30 percent of General Motors cars.

There were lively discussions about spending a large amount of money to determine appropriate press size, cycle time, and the like. People who tended to rely on traditional methods kept saying the cost of such a system might be prohibitive. But, before we had been in 1977 production very long, we had already hit our targets on cost and could be competitive with conventional structures.

Further development of the reactive chemical materials used in this process is allowing the production to be speeded up to a considerable degree. For example, Motorcross and ski boots made in this country by Scott-USA using RIM technology are molded in two separate parts and then assembled. The mold closed time is only five seconds. Total cycle time--including spraying with mold release, cleaning, and removal of the part--is 28 seconds! The boots are molded in an array of automatic machines from which they are taken as fast as an operator can pack them.

Because RIM component materials are the consistency of light oils and easily flowed compared to the peanut butter consistency of conventional plastic materials, the machinery required for RIM products is significantly less costly than the heavy presses required for conventional molding. In addition, the parts only need to remain in the clamped mold for a relatively short time before they can be removed. Continuing development of reaction molding materials, particularly urethanes, is bringing forth a wide spectrum of properties of strength, toughness, and flexibility to suit many potential uses. Controllability of reaction time, including some very fast reactive proerties, makes productive capacity very large compared to conventional molding procedures.

Many molds are required for such a process, and they are needed quickly and at low cost. In making tooling for prototype parts for cars, we have made good progress in the development of epoxy and kirksite molds at much lower cost than conventional steel molds. Such materials may be suitable for production runs of low volume and are made by well established techniques.

General Motors is not in the toy business, but we often look at other areas of technology to see what potential they may offer. In a recent effort, our computer design people undertook to examine the possible application of interactive computer consoles in designing tools to make sculptured objects. In this particular case, we found the utilization of technology available to us from our own developments, and methods derived from the aerospace industry, made it possible to rapidly digitize contours of a sculptured model.

This was done by scanning an actual model to record a large number of points on the surface in mathematical form within a computer. The sculptured surface was referenced to a mounting plane which was the common surface of two halves of the object. The data bank of surface coordinates was then set up to drive a computer controlled milling machine that can produce replicas of the surface sufficiently accurate in shape that a relatively small amount of finishing work will make the contours into a smooth surface. All of the technology and methods applied in this effort are commercially available today. The process offers precise replication, exact opposites for lefts and rights and could be applied to making of lasts or other tooling as well as molds for shoes or soles.

Where in even recent times computers were expensive and often skittish, requiring a large number of specially trained attendants, these devices have dropped in cost and have risen in simplicity and reliability to a point where they can be reasonably considered for almost any manufacturing operation.

In General Motors we anticipate that the use of computers in manufacturing may increase by as much as 400 percent in the five-year period between now and 1982. Pete Estes, President of General Motors, has recently stated that it is entirely possible within ten years, computers will control in one way or another about 90 percent of all new machines in General Motors manufacturing and assembly plants.

At our development facilities at the General Motors Technical Center the computer is found everywhere. Uses include computer-aided design of tools and products, heat transfer models, multiple machine numerical control systems, tolerance charting, plant layout, and machine loading, to name a few.

Computer technology has been used to provide product design and dynamic analysis that has permitted the design of improved machines. In fact, in many cases a computer in some form is hard at work inside the machine itself doing many of the control jobs previously dependent on human operators with varying dexterity and skill levels.

Rapidly declining costs of computer services give small manufacturing organizations the ability to utilize computer techniques to solve manufacturing problems with time-sharing service bureaus which have access to remote computers over phone lines through a relatively low cost terminal. Anyone can now choose from a variety of small business computer systems for his facility. Prepackaged systems cover many areas of manufacturing which can optimize actual day-to-day operations and get more effective results from present facilities.

The use of interactive graphics has much potential for the footwear industry, I believe. A computer aided design system has ability to project differing views allowing examination of all angles. Designs can be translated readily into digital dimensions suitable for making models or tools. This method produces fast results to permit rapid response to changing markets.

Operation of such a system does not require the ability to walk on the water. The manipulation of a design console can be taught to a resonably skilled person in two or three weeks time. After seeing our people digitize the components of a plastic sculptured cow, I believe it is reasonable to undertake the task of designing articles of footwear.

For many years in our business, the idea of doing assembly work with automatic devices has been given serious consideration. Many advances have been made, especially in the area of robot welding. It has only been in the last 18 months or so that we have been convinced that using robots for general assembly could soon be feasible and cost effective. We decided to look at small bench-type assembly jobs, of which there are a great many within General Motors. These include assembly of instrument panels and other small mechanical or electrical units.

Ninety-five percent of the parts in an automobile weigh three pounds or less, according to our recent checks. So many of the manufacturing robots in the catalogs were too large and expensive for the small bench type jobs. We needed a unit that could be produced at significantly lower cost and have several levels of capability which could be chosen tinker-toy fashion to bridge the gap between manual assembly and complex, expensive special purpose hard automation. The first GM designed prototype of this small machine is currently undergoing tests at our shop in Warren, Michigan, to verify its ability to be taught by leading it through the intended motions. It will then repeat its teaching with an accuracy of one-tenth of a millimeter.

In another joint effort with an established robot equipment manufacturer, we undertook development to produce a higher level of programming software. The investment will pay off because laboratory demonstrations of this new machine with its "advanced education" show that the ability to optimize and smooth the programmed path of a paint spray, from both tracking and speed, has produced the ability to program this machine far better than the previous mode in which an operator would manually track the machine through its task. At times the combinations of motions and speed needed to paint the interior of a van would exceed the capability of the most powerful operator leaving the programmed path response considerably less than optimum. The newly enhanced programming capability, which results in more precise tracking, lets the machine produce a higher quality pattern of distribution.

More sophisticated capability is needed in some operations and we are developing various sensors for use with robots, including computer vision. This has been an ongoing joint venture with our GM researchers who have pioneered much of the theory in the field. The ability of robots and other automatic machinery to follow preset programs is now judged by many authorities to be sufficient for programmable and flexible assembly.

Last December, I saw movies of a computer-driven machine for assembling and stitching of footwear. There is no doubt in my mind that the capability of machines like that could greatly increase output. In GM, we currently utilize vision capability robots driven by computers which direct the positioning and assembly of electronic microcircuits. We are using computer-directed devices to follow digitized information or lines on a drawing or template to cut out materials for the manufacture of developed sheet metal shapes. Capability to do the same in other materials used in the footwear industry is clear.

The application of new technology which I have described are in place and functioning beneficially in my industry. To date many of the applications have met or exceeded our estimates, and difficulties caused by delay or failure of technology to materialize have been small. It appears that results have been well worth the risks.

One final concern, however. Technology is available to everyone, except where we come up with innovations that can be kept to ourselves. The race will probably go to those who take the risks of development. In this case we probably should go back and listen to the old general, Nathan Bedford Forest, who said, "The way to win the high ground is to get there fustest with the mostest." I think the possibilities for advancement of the footwear industry by mounting a concerted effort toward developing new technology are tremendous.

Questions And Answers

Q: What period of time is needed to have a payoff using your technique?

Daley: Tom Murphy, the Chairman of the Board of General Motors, has pointed out that it is desirable that our returns should be at least as good as if you put your money in a savings bank. That is a very good test in terms of how your return should go. As a general rule, we ordinarily consider a return of two to three years to be highly desirable. If it is less than two, you have a pretty good case, assuming the money is available, which turns out to be a problem these days. If it is going to be much longer than that, you should be prepared to show ongoing long-term benefits as a need for transition to justify the expenditure.

Q: Do you drive your machine tools with separate computers or in combination?

Daley: This varies, and it depends on the mission that is intended or its complexity. We have one system that we are working on which integrates the operations of 17 machines in a sequential way; they backstop one another in the event of a falldown failure so that the system does not stop. In other cases, equipment may be independently controlled by distributed computers, which are directed by an overall architectural computer (and then they redirect the jobs). In far and away the majority of cases, machines have individual controls.

In some cases these systems will be teachable robots. There are fantastic and ingenious ways of teaching a robot, but if you want to change models, you have to laboriously reteach it. What we try to do now is to figure out how we can psychoanalyze it and switch programs in a flash. That sounds like it ought to be easy, but it has not been. We are almost at the point where we can run through a sequence of different steps and the machine tell itself this is a speedometer, I do this; and this is an instrument cluster, I do that.

Q. To what extent do you have an interchange of information between your research department and people at the Ford Motor Company research department?

Daley: This is an area where we experience extreme difficulty, except in sessions that are of a technical or professional association nature. In many areas we in fact have consent decrees and formal constraints, particularly in areas of safety and emissions, that prevent us from exchanging information with some very serious penalties. Thus, exchange of information within the auto industry is often a difficult thing. This is sort of against nature as far as I am concerned, but we have learned to live with it.

Q: Is there adequate training of manpower and engineers by the universities for the type of manufacturing you are describing?

Daley: I think they are doing a very good job. It is a paradox in many ways. Even though the educational requirements are quite sophisticated, whether you like it or not, the auto industry does not provide a lot of high-level jobs for doctorates in manufacturing engineering. We should figure out how to get out of that one before we lay it all on the educator's doorstep.

I think the current generation of engineering people is very good in the area of computer technology. They have learned to use it the right way, as a tool, not as a mission in itself. The sooner that we can all decide to use computers with the same ease that that we use the telephone, the faster I think we will get where we are going. We keep setting the computer up as some kind of an icon. It was at first, but now it has become a means to a lot of other missions, and we should get on with those.

Q: There are many reasons why an industry will develop modern technology. One reason that I have not heard mentioned here is the declining availability of the craftsman in that industry, this is certainly true in the area of shoemaking. To what degree does General Motors, and I would also add the footwear industry, feel that that is an important factor?

Daley: I think it is a very important factor, and I have gone around and around with Tony Canole, a well-spoken advocate of labor's position. The United Automobile Workers (UAW) in our particular instance maintains that there is no shortage of skilled people at present. I guess that is substantially so, except in certain specific areas. Certainly skill shortage would be a compelling item in adopting modern technology. I think there are other compelling forces, and again I would mention what we did in 1973. I think our management was about to recognize the need for computer-aided design, but OPEC forced immediate action. An economic incentive is always a strong one.

We have, as a written part of our present agreement with the United Automobile Workers, a statement which clearly defines that the ingestion of new technology is an important part of our mutual contract for mutual benefits. The only place where we ever get into any discussions is what do we do in order to manage the transitional displacements that may occur once some of this is done. Who is going to get jurisdiction over what? What are we going to do afterward? You cannot answer those questions in advance; they have to be discussed and handled as they take place. I am sure that they can be managed if we look at it intelligently. Certainly anybody who is considering the adoption of new technology has got to recognize that you are going to change the hierarchical authority systems and disrupt all kinds of things. People are not sure where they will be after everything is done, so it is a delicate situation and has to be considered accordingly.

Q: You mentioned that over the past two years General Motors has adopted a lot of new technology, specifically CAD-CAM and that this has saved many labor hours. Yet over the same period there have been major price increases for the cars. Can you comment on how the new technology has affected your costs?

Daley: In most cases it has helped keep cost down. If you examine those price increases, vis-a-vis the content and functions of the product that you buy compared to the price of footwear, food, or other things, you will find that the rate of price increase of our automobiles has been very conservative by comparison. Technology has certainly helped in this regard. It has provided the ability to simplify designs and the ability to control factory management, as well as the technological design and conduct of operations. For example, a lot of our people were concerned that all the time and money that we had spent on development of interactive computers probably was going to take 100 years to pay off. I asked our staff to go back 17 years ago when this thing first budded in General Motors and add up all of the cash flow out and then measure what we have gained so far. I can submit we have done pretty good with CAD, as far as product design is concerned. We have only made a stab at CAM so far, and that is what is coming next. We have not really done a CAD-CAM job all the way through, but the savings to date have already turned the cash flow positive about three years ago.

MANUFACTURING TECHNOLOGY PRACTICUM

MODERATOR

Dr. Frank Wolek

Deputy Assistant Secretary for Science and Technology
U.S. Department of Commerce

PANELISTS

Frank Daley, General Motors Corporation
Dr. Eugene Merchant, Cincinnati Milacron
Daniel Heidt, Lockheed Aircraft Corporation
Harry Heilig, Western Electric Corporation
Dennis E. Wisnosky, Department of the Air Force
Captain L.C. Dittmar, Department of the Navy

(The discussion was recorded, transcribed and edited for smoothness. The speakers have not reviewed the comments attributed to them.)

Wolek: We now have an array of talent. Let me introduce those who will answer questions -- Eugene Merchant, Director of Research Planning from Cincinnati Milacron Corporation; Mr. Daniel Heidt, Director of Manufacturing from Lockheed Aircraft Corporation; Mr. Harry Heilig, General Manager of Research and Development, Western Electric Corporation; and Mr. Frank Daley. The Department of Defense, which has an active program of encouraging manufacturing technology developments, has sent Mr. Dennis Wisnosky, Manager of the Integrated Computer-Aided Manufacturing Program for the Air Force Materials Laboratory, and Captain L. C. Dittmar, Chief of Naval Materiel for the Navy Department. Are there any questions regarding the techniques that are being used elsewhere, particularly concentrating on any managment lessons learned from the introduction of these techniques.

Q: Please describe some of the activities in the overseas countries using advanced technologies for manufacturing footwear?

Merchant: I will try to summarize the general approach in Japan and in the European countries, of which Germany is perhaps the best example. Virtually all of the industrialized countries have recognized the fact that the major wealth-producing activity of a country is its manufacturing industry which produces, on the average, about two-thirds of the new wealth in those countries.

Thus, most industrialized countries have coordinated programs to assist their manufacturing industry in developing and implementing advanced manufacturing technology as the major factor that keeps their industry healthy and makes their manufactured goods competitive on the world market, giving them a greater share of the world market. They have focused particularly on developing a generic manufacturing technology that can be used as widely across the manufacturing industry as possible. In recent years by far the most generic and most effective in reducing costs, increasing quality, and providing flexibility to manufacturing is computer-aided manufacturing coupled with computer-aided design. That is the area in which these governments have concentrated.

The strategy used by most of these countries is two-pronged. To do effective research, development, and implementation of advanced manufacturing technology requires both a systems approach to manufacturing and an overall cooperative activity, involving government, industry, and universities. They have set up excellent mechanisms for each of those three to contribute to overall advancement in this area. Each has their understood role, and in each case there is a strong coordinating mechanism which varies from country to country, but still provides a basis for coordination, usually through committees made up of representatives from government, industry and universities.

In Japan, for example, there is a cooperative national program to develop computer-controlled prototype factory in about the next six years, which has received $50 million of government funding and a lot from industry too.

There are many such projects, and hundreds of millions of dollars are being spent by these governments and by industry.

Wisnosky: Last year I went with Dr. Merchant to look at Japan, Germany, and some other countries. I have a report which is available to any American Company.

Q: Have you experienced any restrictions in your use of computers for fabrication or assembly of your product, that is restrictions that might affect your marketing of the final product?

Daley: If we had anything that the use of computer aids restricted our ability to do, that would be the first reason that I could think of to do something else. In other words, we would not accept any restriction based on something that was introduced by the technology of the system.

Heidt: We do not have any restrictions in terms of the product because that is controlled by various government agencies for export. However, in terms of the technology being transported out of the country, there are certain restrictions there.

Wisnosky: The contention seems to be just the opposite for the use of computer-aided design and computer-aided management. The use of this technology enables one to respond more quickly to engineering design changes brought about by changes in styling requirements, aimed at a new market or at a change in an existing market.

Wolek: William Abernathy, Harvard Business School, is a student of manufacturing technology and the management process for that. After studying the implementation of these technologies, he has found that the general lesson that the technology must be incorporated into the administrative structure of the organization and have a package of benefits, including reduced costs, marketing advantages, and an administrative structure simplification, is an important concept. Otherwise, the technology has great difficulty making progress. I am wondering about the effect of computer-aided manufacturing on the work force and any problems in obtaining the cooperation of labor in the adoption of these technologies.

Heilig: I will comment on that. In the electronics business, without the use of high speed data processing equipment today, it would be very difficult to even manufacture the product. Design information from our design agency, Bell Laboratories, comes to us in a variety of forms, but is almost always machine readable. We put the information through automatic equipment which does the processing and creates that design. Because the testing of our product is also done automatically with a computer, it has to be a part of the design consideration by the physical designer when he starts out. He has to transmit that information to an engineer in some way so that he can go through the process of manufacturing. Thus, we in the electronics industry have long since passed the stage where it is possible to live without some form of automated data processing capability.

Wolek: Since we have some people from the government who are trying to help introduce manufacturing technology, I wonder if any lessons have been learned in the Department of Defense programs about working with small as opposed to large companies.

Dittmar: The Navy has been rather late in getting involved in this program. We only have 57 projects funded right now, and only two of those are completed. One thing that is evident so far is the transfer of technology from one company to another. There is a reluctance to share with their competitors what they develop on our money. Actually, the firm that develops it is still ahead for a couple of years anyway.

Wisnosky: The Air Force has been in the manufacturing technology business since they needed to learn how to make better fabric to put on airplanes. The whole aerospace industry is interwoven with some big companies as primes, others as subcontractors, and then small companies which may manufacture critical components. We use small companies in procurement as second sources and for satisfying critical needs. We actively encourage small companies to participate in the manufacturing technology program directly. My opinion is that we do not need new institutions, but rather a better way of managing the introduction of technology within the institutions that exist. We do that in the Air Force by doing technology development where the problems really are. If a company is having a problem, we will try to solve it in that company by bringing in help from other parts of the industry, with the stipulation, they share the results with their competitors.

Q: What is the extent of the financial resources needed to get into this type of technology?

Daley: Without being facetious, the answer is that it depends on how far you want to go. The initial foray of determining what you can do and putting it into a frame of reference for your company would probably cost about $10,000.

Heilig: Because of the size of a typical company in your industry, you have a serious problem here. Computer-aided design or computer aids to manufacturing are not inexpensive and must be upgraded all the time. You will need a software specialist to write the programs for what you want done. You might discuss this with the Department of Commerce which is looking for areas in which they might be of assistance to the industry. You need a sharing arrangement, either of a terminal, software packages, or time, for example. If you can use this powerful tool by pooling your resources in some way, you will be very impressed and pleased with the results.

Heidt: There is one comment I would like to make about developing and implementing these new technology systems. Implementing these technologies into a productive atmosphere requires a firm commitment by the executives of the company. You will encounter massive resistance from management and your labor force. In many cases I found that in order to make a unit use a technology that has been developed, I had to completely remove the capability of doing it the old way. The only way they could get the job done was to use the new technology. Therefore, when you look at these new technologies, also look at the alternatives that will be available at the time to either subvert or change technologies and thereby not realize the benefits to be gained.

Baruch: As you are probably aware, Dr. Wolek, myself, and others in the office have been working on the concept of some form of institutionalization of basic technology development for various industries. The shoe industry is a classic example. When we look at the problems of CAD-CAM, it may not only be necessary to have a cooperative center that develops such equipment and facilities, but also to have some form of cooperative that uses them operationally. One of the intriguing things about being able to work with an industry that's in a little bit of difficulty is that it catches the attention of the Economic Development Administration. They are interested in technologies whose size make them inappropriate for the small firm but appropriate for the whole industry. CAD-CAM could clearly be one of these technologies. It does not generate a comparative advantage for a single company but in fact can do so for the entire industry, elevating the productivity and competitiveness of each firm in the industry. Ask the question, is this something which a group of firms in my industry could share? Let us worry about the Justice Department and about the basic capital needs, at least for a while.

FOOTWEAR TECHNOLOGY PANEL

MODERATOR

Dr. Frank Wolek
Deputy Assistant Secretary for Science and Technology
U.S. Department of Commerce

PANELISTS

Robert H. Bode, Arthur D. Little, Incorporated
Gordon E. Pickett, Battelle-Columbus Laboratories
John C. Williams, Illinois Institute of Technology Research Institute
James P. Kottenstette, Denver Research Institute
Dr. Nam P. Suh, Massachusetts Institute of Technology
Dr. Jordan J. Baruch, U.S. Department of Commerce

Wolek: Bob Bode from Arthur D. Little, Gordon Pickett from Battelle-Columbus Laboratories, Jim Kottenstette from Denver Research Institute, Jack Williams from ITTRI, Dr. Nam Suh from MIT, and Jordan Baruch from the Department of Commerce will now respond to questions.

Comment: In our session there was general agreement that most of the papers presented missed the mark, possibly because of a lack of specific knowledge about our industry, our real problems, and the limitations that would have to be imposed on any solution. What could be done next time to get more input from the industry?

Williams: Give us more time, not money. Let us spend some time in your plant with your people. We need more time to make that initial intelligence grasp.

Suh: In my experience in working with a large number of companies, the identification of the real problem only comes after a long period of group discussion. What will eventually end up being the problem is not the same as what any one person in the room originally conceived to be the problem. As I see it, this is essentially the problem with this particular industry. We have to have a fresh viewpoint, try to define what the problem is jointly, and then we see where we go from there.

Q: I have a couple of questions. One is a definite industry problem--the need to rough all leather before cementing soles. Can someone develop a technique to force the cement into the leather so that we would not have to rough it. We damage a lot of shoes doing this, and the wear of the shoe is not as good. Next, any breakthrough on stitching would certainly help this industry because 45 to 50 percent of our labor is in the stitching room. Last, what help will be given to small- and medium-sized companies in financing these innovations?

Bode: Our approach was directed at going from bulk semiprocessed material to a nearly finished upper and eliminating any problems associated with roughing, cutting, the fitting room, or lasting. You have demonstrated this approach beautifully within the industry in your modern bottoming techniques, but you have done almost nothing for a quality upper.

Pickett: At Battelle we also came up with a couple of concepts of improved adhesive bonding involving some induction heating techniques. Whether these would get around the problem of roughing the leather or would eliminate stitching has yet to be proved. However, I think it is a technology that deserves consideration.

Wolek: A number of the technologies presented by the contractors are already being worked on some place in the industry. There is also concern about the general innovativeness of the industry or the extent to which it is likely to respond to the challenges that are before it. By merely coming to this program, you have already indicated that you are innovative and open to moving on the changes that are reasonable for your industry. Now, where is the money, resources, and talent going to come from to move faster on these technologies so the industry gets the benefits? What we also need is your sense of the priorities from our limited resources.

Butlin: One of the quickest places that new technology can get into is the Far East, Middle East, and Eastern Europe. How is your thinking going to affect the competitiveness of the industry and its survival?

Bode: One of the principal problems with this industry is labor intensity. By developing automation and processes that are capital intensive, you remove the labor intensive aspect. Then it does not matter where that technology moves throughout the world because the United States will always be competitive. You are competitive worldwide if you only do one thing--remove labor content and transfer it to the service industries.

Baruch: One of the disadvantages the United States shoe industry works with is the fact that finished leather is cheaper overseas. They buy raw hides here, ship them over there, and finish them, because that segment of the industry is also highly labor intensive--tanning and finishing.

Comment: Your assumption is not valid. We are competitive in Korea, Taiwan, and Hong Kong, in fact with everyone except the Japanese, who sell cheaper outside Japan than they do in Japan. Pressed leather from Argentina is a lot cheaper, but to make a good full grain piece of leather you have to make it from American hides generally tanned here. Western European leather prices are higher than ever. The differences that come from finished leather goods made in the Orient I think are engineered somewhat by their governments rather than in any lower labor costs.

Baruch: If that is true, it gives us data to seek the kind of countervailing duties that such engineered support activities recommend.

Comment: We have asked for it.

Baruch: There are other methods than asking for them, and one is to sue for them.

Comment: Due to section 301 that's been filed........about 8 months....

Baruch: Customs court?

Comment: But with the Special Trade Representative in the trade procedure in section 301. It is not resolved yet.

Comment: We've been fighting the same battle for Zenith.

Comment: Zenith lost a similar case which shows that if you have the data, it has to be clean and presented because the courts, particularly the Court of Customs and Patent Appeals, are really very tough on it.

Comment: The AFIA set up a committee to consider the industry, and they submitted the needs of the industry to the Department of Commerce. Was that paper considered during the study of this industry?

Wolek: Because we were looking for creativity, we did keep the report temporarily from other people that we would be working with outside of the industry itself. That report has been discussed though. The footwear center, for example, which we were told was the number one priority on the industry's list, is moving ahead rather rapidly. I will be able to report a little bit more about that tomorrow.

Comment: What is the amount of added cost which the American industry experiences from regulations, reports, and other red tape that we are compelled to follow to comply with existing laws that our foreign competitors do not have? This is an area that could be a real help to us if we had some way to reduce those costs. This is a cost that the government is imposing on us. It might be well for the Commerce Department to make a study in this area and see what can be done. It appears in every part of our business--in our factories, our accounting department, our insurance department, our tax department, right down the line. When you total it and then compare our cost to foreign cost, there is a tremendous difference.

Baruch: According to Margery King, that category called other, which I suspect covers these costs, amounts to about 26 percent of the cost of the shoe. If that is so and labor amounts to 25 percent, we ought to tackle both of these areas. If the shoe industry does have any data on what the government-imposed costs on a pair of shoes are, I would appreciate seeing it. The government as a whole has started a paperwork reduction program. If we can get from the industry some indication of cost, this is an enormous lever that we can use. We are indeed part of the problem.

Wolek: Existing units of the Department of Commerce make that type of study. It is not impossible to incorporate them in our overall effort. The Industry and Trade Administration and our own Office of Environmental Affairs do exactly this type of thing.

Kleiman: As one of the contractors working on this, I would have preferred not to have seen the AFIA paper. I think we lose objectivity. However let me address another aspect. You keep coming back to the fragmented heterogeneous nature of this industry, and lots of the probems are attributable to that condition. Other highly concentrated industries such as consumer electronics, steel, and automobiles, have experienced almost identical problems. Obviously, there are other things going but, I think, much has to do with the basic nature of how American industry looks at itself. I think it is much more fundamental and possibly relates to what I suggested before--this blind spot that the U.S. has had, even in analyzing our own marketplace. That the Japanese and Europeans do this better than we have seems to be a common thread that runs through a lot of these industrial problems.

Wolek: There is a general approach of trying to make sure that the competitiveness between countires is on an equivalent avenue. We are looking at various tax treatments, financial benefits, non-tariff barriers, etc., that are provided between different countries. The Department is attempting to reduce them as much as possible, or to get countervailing duties charged for those that cannot be reduced. I assure you that effort is going on.

A MATTER OF TRUST

Dr. Sidney Harman

Under Secretary, Department of Commerce

Thank you all for coming. I spoke to the President about our progress in the shoe program a couple days ago. As a consequence of that, I have a message which I would like to read to you:

> Fourteen months ago when I rejected the tariff rate quota on shoes recommended by the International Trade Commission, I said that over the long haul, the solutions to difficulties in the shoe industry lies not in the restriction of imports but in innovation and modernization of our own production facilities and the financing to make these possible. This Footwear Technology Symposium is a critically important step toward the strategy for the shoe industry to gain a competitive advantage through technological development and utilization.
>
> It is also a pioneering effort in public/private cooperation to advance technological capabilities in civilian industry. I want to express my deep gratitude for your participation and my confidence that these proceedings will advance the national interest by helping to preserve jobs and improve profitability in a vital American industry. /Signed/Jimmy Carter.

I like that message for a number of reasons. In the first place, it does speak to an element of our experience which I regard as historic. For the very first time ever in our history, not in time of war, government and an industry have engaged in cooperation on a truly collegial level. There is no precedent for what we together have been doing in the shoe industry. Although we may from time to time have our differences, we have come through 14 months of significant times based very substantially on a growing mutual respect and fundamental trust. Almost everything that I want to say tonight is concerned with that matter of trust. I must share with you my very favorite story with respect to trust. It has to do with the intrepid mountain climber who lost his footing -- I will not tell you what shoes he was wearing -- slipped, and was tumbling head over foot to his certain death at the bottom of an enormous chasm. At the very last moment he managed to seize the last remaining limb of the last remaining tree. Clinging to it for dear life, he turned his face heavenward and implored, "Is there anyone up there?" A deep, sepulchral voice boomed through that canyon, "I am here, my son. Let go of that branch, and I will take care of you." Then, the climber said, "Is there anyone else up there?"

I suspect that fourteen months ago many of you were asking the same question as you approached government. As I reflect on what we together have done, that word trust keeps coming to mind. It is my recollection that the shoe industry of fourteen months ago held a rather strong conviction that nothing except import relief was going to help. There was also serious skepticism that there would be genuine support for that point of view at the Department of Commerce, or that the Department would produce anything worthwhile in terms of revitalization of the shoe industry. We had our difficult beginnings, we forged through these difficult beginnings a relationship which I believe is still growing and which will, in the end, give us precisely that vital self-nourishing, self-sustaining, growing shoe industry.

Let me tell you something about that by referring to the Orderly Marketing Agreements (OMA's). Fourteen months ago I was not a vigorous supporter of any form of import relief for the shoe industry, and I never deceived anyone with respect to my point of view. Indeed, in my very first conversations with Ron Ansin and others, I asked whether the time being sought would be used in a sufficiently constructive way so that at the end of that spell, an industry would exist which could be self-sustaining. I did not think that a program that provided only protection would do anything except delay the inevitable, and as a businessman, I saw no sense in that at all. OMA's are, however, one of the tools available to the Department of Commerce as we work with you. If I am not now the great poet of OMA's, I am quite likely its most earnest advocate because it is an instrument that can be used effectively while we are working together.

As an example of this, my associates and I are regularly in communication with the President's Special Trade Representative, Robert Straus. He is a very important component of our program, as are the OMA's. Due to the close working relationship between the Department of Commerce and the Special Trade Representative, we are ever alert to new efforts to escape the meaning of OMA's, wherever that may occur. The situation in Hong Kong is one example. Mr. Straus has assured me that should the evidence indicate that the spirit of OMA's is being circumvented in Hong Kong, OMA's will be pursued there. The same will be true for other places, such as the Philippines if the need for vigorous action is determined. I am no less convinced, however, of the importance of a program designed ultimately to strengthen the industry domestically so that it can stand on its own. The whole meaning, purpose, and spirit of this symposium, is directed to innovation. However, innovation is not limited exclusively to technology and its application. Frankly, I am disappointed that the attendance at this symposium is essentailly limited to officers and production or technical people of the shoe manufacturing companies. If I were running a shoe business today and I knew that there was a symposium on new technology taking place, I would send my marketing people to that symposium. Indeed, if I knew that there were a significant merchandising symposium taking place, I would send my design and manufacturing people to that marketing symposium.

One of the difficulties in industry, whatever the product, has been this curious separation of operations. In every company that I know that is truly vibrant and growing, there is integration of styling and design with production procedure, personnel relationships, and costing processing. For example, every one of those successful companies has always had for its controller a person who became very interested in how the product was made. Every successful company that I know has done that interesting job of integration at every level.

In my pre-government days, I was actively involved in developing new forms of worker-management collaboration and participation. I learned a great deal in the seven years of that program. This evening I was talking to Mrs. Haynes, herself an industrial engineer, and the wife of Fred Haynes who spoke today. I commented that in the Harmon companies no industrial engineer would go down to a production line without talking to the people on the job. Their knowledge could then be used to revise the way in which the work was being done. In the early days of our efforts I would talk to somebody on the line in one of our plants. The colloquy would go something like this: Hi, how long have you been with us? Twelve years. How long have you been on this job? Ten years. Do you do the job any differently now from the way you did it five, six, or ten years ago? No. Do you know a better way to do it? Yes. Why haven't you spoken of that better way? Nobody ever asked me. There is something so fundamental in that experience which was repeated every time I went to one of our plants. It did not take me terribly long to realize that we were passing up one of the profoundly important resources in our company. Much of my later efforts were a consequence of that experience.

That realization that the people who do the work, especially in labor-intensive manufacturing concerns, carry with them such a valuable store of information and experience demands that when we look to the most effective application of new technology we should talk to them. When we think in terms of how better to use our present machinery, we must talk to them. I offer you that because it seems to me that in the shoe industry there is room for that kind of innovative address to the people who do the work. It is innovative in terms of setting an atmosphere which encourages their participation in the decision making process that designs their lives at work. If this then is a symposium on innovation, there is one that I would identify.

If this is a symposium on innovation, I need not talk long about the opportunities in technology. If it is a symposium on innovation, I urge that the experience I have had with the shoe industry has taught me that there are many companies which really do not need money, technological assistance, or new computerized equipment at all. There is many a company that knows perfectly well how to turn out a superb product and nothing about how to market it. If there is to be innovation, we ought to see it in that same integrated fashion I was talking about before. Learning how to market that product should be part of that innovative process.

Altogether then, as I reflect on my total experience in this shoe effort, I conclude that the good things that we have been doing are to recognize that we must use every tool available to us. The Department of Commerce is no one's automatic advocate. We serve industry poorly if we are their messenger boys. I think that what we have to do is to bring to all industry a sense of our own competence, our own professionalism, and our dedication. We should work with a particular industry about their problem and ultimately synthesize a point of view between us of which we can then become the full, unqualified competent advocates. That is what we are doing in the shoe industry.

While I was not the great OMA advocate at the beginning -- and I am really changing my mind about that -- I am more to be trusted in terms of how forcefully I will use those OMA's and how hard I will work for their extension as we work together. I am more to be trusted in that respect than if I had not from the very beginning set myself before the industry in terms of what I am, what my experience has been, what I believe in, and what I know can be done. Thus, (a) we use the tools that are available to us and we use them to the very maximum, (b) we explore in every way possible the differences that exist from one shoe firm to another, and we deal almost in a cultural sense with the managers of those shoe firms entirely in the role of a facilitator. The government should play no role beyond that; the ultimate responsibility for the shoe industry is the shoe industry. We can be very useful in that role as facilitator. We can also be very useful in recognizing the instruments of government and their applicability and in retooling them where necessary. We might speed up the process of certification or the step that follows the diagnostic studies, in fact, speed up every activity in which we engage with you. All this is aimed at the ultimate consequence of a truly vital, vigorous, self-sustaining shoe industry. We want very much for that to happen, and we want very much to do that job well. We have devoted ourselves with enthusiasm and professionalism to doing it, and we intend to continue to do that.

Let me close by suggesting that somehow through my observation tonight there has been a implicit theme. It is that this world is an infinitely more complex one than the one we came into and that this industry is an infinitely more complex one than the one you first encountered. Some years ago, H. L. Mencken observed that for every inordin tely complex problem there is one single simple solution, and it is wrong. I think that you can agree with me as you reflect on your own times in this industry that never was a wiser aphorism offered about the shoe industry than that. I add to it the thought that the time has come to end that curious separation that I was talking about before. In more general terms it is those people who are concerned only with the technical and mechanical aspects of things as distinguished from those who are concerned with the human aspect of things. It is the way industry and, in many respects, government and other institutions have operated for far too long.

I argue that the day has come when there has to be a merger of the mind and heart in industry and that that merging brings with it ultimately the best results -- the best spirit, the best marketing, the best sales, the best productivity, the best profitability, the best return on investment. Probably this view was never better expressed than it was 3,000 years ago by Mencius who, as I remember, put it something like this: The men of old wishing to clarify and diffuse throughout the empire, that light which comes from looking straight into the heart and acting first set up good government in their own states. Desiring good government in their own states, they first organized their families. Wishing to reorganize their families, they first disciplined themselves, and desiring to discipline themselves, they rectified their hearts. Thank you very much.

INDUSTRY RESPONSE

Ronald M. Ansin

Chairman, Anwelt Corporation

It is my pleasurable task to respond to Dr. Harman's presentation on behalf of the American footwear industry. I also had the earlier pleasure of working with Dr. Harman in the development of this original program on behalf of the American footwear industry.

First, on behalf of the American footwear industry, "Thank you." Thank you, very, very much. Thank you for the help you have personally given to this industry and the dedication you have brought to it. You've personally been accessible. You have personally been a friend to this industry: a friend when this industry needed a friend. This industry deeply appreciates that help. In the past, we have not had that sort of help any place in government. It's been much like the story - "Is there anybody else up there?" I think today we have somebody else up there.

We don't always agree on things. We sometimes see things in different lights. Some of those disagreements are real and some of them are imagined, and, I suppose it will always continue that way. Personally, I've always been hopeful that if we could just increase communications through these sort of discussions, we could get even greater cooperation in the doing of the task which we all adovcate.

I particularly appreciate your remarks today with respect to the OMA's. I too was not an original advocate of the OMA's. I changed my position about a year ago, after I studied the statistics and realized that the problem we faced three years ago was not the same problem we faced a year and a half ago. And so I became an enthusiastic supporter for the OMA's. Today, I think these agreements are vital to the continuation and growth of the American footwear industry.

I think a specific action with respect to Hong Kong is most significant. Hong Kong represents an undercutting of the Orderly Marketing Agreements for which we worked for so diligently. If the cutback from Taiwan is simply to move across the straits to Hong Kong, obviously we did not accomplish a thing. Thus, I think this action is significant in its own right. I think it is also significant as an indicator of the teeth in our verbal understanding that there would be a "cap" on the rest of the world.

For all these reasons, I deeply appreciate the support which you conveyed to us tonight, Dr. Harman. While you have previously indicated to me and leaders of the industry the kind of reservations you have very forthrightly described tonight, you have also told me to consider you and the Department of Commerce a champion of this industry.

I have no doubt about that! I've worked with Dr. Harman. I trust him. I assure you of that. I think our industry can trust this man. I think he means exactly what he says.

Two things Dr. Harman referred to in his comments this evening rang a bell with me. First is the need to integrate production and marketing, which we, along with many other industries, too often keep separate. Marketing is the ability to sell the product, therefore the ability to design a product that people are going to want. We <u>must</u> keep in mind the integration of marketing and production, not just marketing in the sense of selling, but marketing in the sense of developing the products people are going to want.

Second, I personally have had some experience in the footwear industry, similar to that of Dr. Harman, in terms of the participation of the people who do the jobs. I could not agree with him more. There is no one <u>ever</u> who knows more about how to do a job or know how to do that job better than the guy who does it. The greatest untapped natural resource I know, the greatest energy source I know, are the people in the factory who do the jobs. That's the secret weapon of the labor intensive industries. I hope we will take that to heart and will begin to tap that resource to an even greater extent than we ever have.

In conclusion, and on behalf of the industry, I convey to you, Dr. Harman, our deep appreciation, our continuing trust, and our thanks.

OPENING REMARKS, FRIDAY, JUNE 2, 1978

Dr. Frank Wolek

Deputy Assistant Secretary for Science and Technology
Department of Commerce

At this point, I would like to talk briefly about something which I know concerns many of you-the establishment of a footwear center. It also concerns the Department of Commerce because we, like you, believe that we need not only specific new technology, but also a permanent institutional structure within the industry for generating and implementing that new technology. This structure should also be capable of providing the assistance you need for utilizing existing technology, as well as developing new processes and products.

Those beliefs were incorporated in the AFIA proposal to the Department of Commerce for a Footwear Technology Center, to provide technical and managerial assistance to the industry. We in the Department of Commerce agree on the need for such a center and the value that a properly established center would have. We are now actively working with the industry to determine what the specifics of "properly established" means. Both the industry and the Department agrees that a properly established center will be one that represents a sound business investment for the membership fees that will be required. It will provide benefits in terms of the returns on the funds that you in the industry provide for the continuing operation of such a center. Everyone involved is looking forward to a date early next year when we can announce a commitment to a specific location and structure for such an organization.

When that organization is established, it will fit nicely into some plans that we are also working on in the Department of Commerce to provide research and devlopment support on an ongoing basis to industries like the footwear industry. This would include support on the kinds of projects discussed during this symposium. A research board representing the retailing, manufacturing, and supplier communities will hopefully be in operation by fall of this year. It will process the reports of the contractors and other ideas that will be canvassed from the industry and present a project priority list for support by the Department of Commerce.

Therefore, I think with the structure of research and development activity on a project specific basis, coupled with an ongoing Footwear Technology Center, we will be able to provide the kind of assistance that you in the industry are asking for and that we in the Department are committed to providing.

INDUSTRY VIEW

Frederick A. Meister

President, American Footwear Industries Association

It is a pleasure to be here this morning. I have been in the footwear industry for only the past four months. Before that I was in the airline industry, which is supposed to be technologically advanced. Let me tell you that the same debate is going on within that industry as the one I have heard during my brief time in the footwear industry. Before that I was associated with railroads and mass transit. From my experience dealing with these kinds of things, I think the footwear industry is advanced. The people in this room are progressive, intelligent, capable people.

For the Department of Commerce, as well as for the footwear industry, this particular type of session takes a lot of courage. It was very difficult because there is a fine line between suggesting and demanding on all of our parts and between negative versus constructive criticism. It is also difficult for government and industry to relate and to deal with one another; I think it can be done on the basis of an equal partnership with the government. We are well along toward establishing that with the Department of Commerce.

It will not work as a boss-subordinate relationship or without advocacy for the viewpoints of both sides. Some comments yesterday suggested that advocacy on either side is inappropriate. I do not think that is true. The industry has every right to ask, to push, to shove, to argue, and to advocate our positions, and the government has a responsibility and obligation to do the same with us. Good, open debate is useful for finding some solutions and some new ways of doing business. I have not met anyone in the industry who is not willing to adapt themselves and to adopt new technologies in order to do the job better. The presence of so many people at this conference is a tribute to that fact. So, as a representative of AFIA I would like to thank all those in the Department of Commerce who have worked very hard with us.

My topic this morning, is "Industry Review," but first I would like to provide a few facts regarding imports. One reason for this industry's problems is that import penetration for the past five years has been between 46 and 52%, mainly from

Korea and Taiwan. We were quite successful in working with the Department of Commerce and special trade representatives in the Congress to get some form of import relief. Import Controls are the critical framework within which these new industry programs can develop and be successful. Without continued strong enforcement of the orderly marketing agreements and import controls by the government, we will not have the opportunity to adopt many of the things that will come out of this conference and subsequent work with the Department of Commerce. This is an important framework for us to operate in.

Turning to the issue of technology, I would like to present the ideas that the industry has submitted to the Department of Commerce. There are five areas--the Footwear Center for Education and Technical Service, improved market information and market research, special applied research projects, technical assistance projects for individual companies, and increased exporting assistance.

In the first area, educational courses for top management in marketing and manufacturing would increase the educational base needed to keep our industry up to date. Training courses for supervisors, technicians, and designers are a way to get more design capability into our industry. The evaluation of new technologies and their potential application to our industry, as well as the dissemination of technical information touches on a problem mentioned several times here. A facility for developing product reliability and manufacturing standards should also be considered. The main idea again, however, is to establish a center that can contribute educational and technical services to the U.S. footwear industry and that would be oriented to our problems, not the problems of other countries. Firms would pay dues and would receive benefits in excess of the costs.

In the marketing area, our specific proposals included an assessment of government-collected data to make it more useful to the footwear industry. The second proposal, the development of market research models, recognizes both the importance and the cost of market research. We have asked the Department of Commerce to help us develop some software packages for different sized companies that could do much of the basic work and eliminate much of the high costs of market research methodologies for the industry. Consumer research is needed to understand the needs of the American consumer better.

Special applied research projects mean the evaluation of ideas that have not been pursued by suppliers or have been pursued at one point in time and then dropped for one reason or another. Some examples include the role of the computer in our industry, fitting room productivity, development of inexpensive molds for injection molding, and the development of non-rough upper leather. This last area relates to problems on the part of the consumer which yield costs additional to the direct costs in the factory. The return of footwear by the consumer is not the way we increase profitability. Those are four areas where we think something could be done and cost efficiencies achieved.

In the next category of technical assistance to individual companies, the Department of Commerce was asked to disseminate to the entire industry information that comes from the Footwear Industry Team. I understand they have done this. A number of individual companies are receiving benefits from the so-called "FIT Diagnostic Program" and the subsequent adjustment plan, but we felt there would probably be a wealth of information in these particular efforts. First, it must be desensitized to remove individual company data and proprietary secrets and then summarized to provide a useful document. Thus, the industry could benefit from the examination of different types of companies and operations by many experts. The Department of Commerce has taken the first step with the consultants to do that.

Another effort under this category is audit for the noncertificated companies. Many, if not all, companies have been injured by imports. Thus, Department of Commerce-funded audits should be the means by which companies not certificated under the Trade Adjustment Assistance Program could receive some share of the government program. There would be cost-sharing on a 25/75 basis for those firms who were not certificated and yet wanted to avail themselves of assistance.

Grants for improving manufacturing methods would allow individual companies to apply for technical and economic assistance from the Department of Commerce. This could involve the purchase and modification of existing manufacturing of equipment. These grants would be made to companies having ideas for improving productivity. Funding would allow them to implement those proposals.

Investment incentive provisions would supplement limited technical assistance programs. The government should explore the possibility of providing accelerated depreciation, more substantial capital investment tax credits, and dispensing of various regulatory expenses, such as OSHA, for the industry. This longer term process is important if our industry is to achieve fundamental and long-term stability. That the short-term technical assistance is insufficient for this purpose and that we need some assistance in this area, is not unique; other industries such as airline and housing have it.

We are working actively in our industry to promote the fifth area, exports. The Department of Commerce has been most cooperative in setting up an export program with us and this September a number of firms will go to Dusseldorf to show their products to try to get into the European market. This will be followed by trade missions to other countries, such as Sweden, where there may be a substantial market potential.

This five-part program, submitted to the Department of Commerce in February, tries to reflect the thinking of some if not all of the members of our industry. We hope that all of these in some form will survive the government-industry process and that in sum they will be useful to all of us. Thank you.

RELATING TECHNOLOGIES TO THE MARKETPLACE*

Beth Levine

Footwear Designer

Relating technology to the marketplace. I do like the subject given to me for making any contribution I can to the symposium. To me, it means that a designer is constructive, practical, aware of the facts of marketing life, does not work in a vacuum, and even possesses common sense. I am really thankful for that profound understanding.

Let me define, as I see it, the problem and then the planned strategy. The U.S. gave the world the idea of mass production; the idea of shoes in pairs; and the idea that more sizes means more satisfaction and greater sales. Stimulating desire by more variety in style and design opened new avenues of appropriate use and function. We encouraged freedom of choice as part of our democratic blessing. We gave the world corn, tobacco, potatoes, and the American native moccasin, patent leather and the cowboy boot.

We brought with us from the Old World the respect and the love of the well-crafted shoe, and we developed a remarkable industry that made us the best shod nation in the world. We had leather, wood, cotton and steel, among other things. In addition, we had technologists for developing rubber, new concepts in weaving and fabrication, and tanning developed to a fine art. We employed a lot of people. Do you know that, only a few short years ago, the shoe industry in our country was the 12th largest employer? At that time, it was a matter of great concern to President Kennedy that we needed young people to become valuable workers in a much-respected trade. He knew then what we are facing now, and saw that more jobs might lead to less crime in the streets, too.

History may be defined as the art of trying to understand and control the future. Whether the past stays alive depends largely upon the lessons we draw from it and utilize in the present. So, we were great, smart, and fat in the pocket, and we could be nice people and enjoy playing Lady Bountiful. Don't mistake me; I am glad I am on this side of the Marshall Plan.

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*Beth Levine started her presentation by showing a 5-minute film which chronicled new fashion trends and materials in footwear she pioneered during her many years as a footwear designer, all still current in fashion and the industry today.

Yes, it was cheap labor we were seeking, but while this was happening, we were cheapening ourselves. We were cheapening our goals, our abilities, and our integrity to the consumer. We forgot that we were supposed to be ingenious, pioneering, daring and decent, with taste and judgment. We forgot that productivity combined with creative design and technology countered cheap labor.

Before the tanners had the excuse of protecting our environment, by and large they gave up trying to develop quality leathers. A lessening of standards, having nothing to do with price, permeated the market. We had a Hubschman, a Lowenstein, an Agoos, and Davis to the north in Canada. They still refer to Davis in Paris for nobody made colors and finishes as well. Incidentally, does anybody use leather insoles in your shoes? The inside of the shoe is what touches you; the insole is the foundation of the shoe, but I know of no shoes left in this country with leather insoles, except for some men's shoes. The outsole is one thing, and there are things we can do about it with leather and good synthetics, but I suggest the tanners do something about the insole. Forgive me for emphasizing that so strongly, but it is a very important point.

Blending technology and design is a must! This story illustrates another point about leather. We wanted leather some years back that was noncrack for soft boots. That was asking too much, so we found it in France. After that, I wanted to make a leg-fitting boot. Vamos had something that almost worked, but the company that made it would not even try to make it workable. I found stretch vinyl from Cohn-Hall-Marx. We struggled with it, and found that within their own company they had another type used for upholstery. I wanted the two wedded to get the desired result, and that was not easy either. I wanted colors for our business, and they would not make brown. They had discontinued it. I found some at a jobbers.

Things changed when the stretch boot became a resounding success, of course. Still, I wanted it smoother to slide more easily over the stockinged leg. The original vinyl had a fuzzy back. I found stretch urethane, made with nylon, in Italy. The maker tried to dissuade us from using it, because it was not strong-enough and scuff-proof-enough for shoes. We asked him to make it better, and the whole world enjoyed those results.

Let me mention one other example. I thought it would be nice if we had the comfort in our leather dress shoes that was enjoyed in sneakers. So we put crepe soles on patent leather, kid and calf. We did it first on a wedge pump and a moccasin, then a sandal, and then a boot. To ask for something special and finished was fruitless for us. We cut plantation crepe and then experimented with making chemical mixtures and adhesives, so that the soles would not peel like a banana. At one time, it was an innovation just to put a crepe sole on a leather shoe, but they thought you were trying to save money. Once a tough, conservative and important retailer said to me: "I don't understand you, Beth. You fight harder for one pair than anybody else would for a 100,000 pairs. Why do you do it?" I answered "if one pair of the new idea gets on the feet of the right person at the right time and place, it could mean millions of pairs." It has happened. I can prove it. Thinking big often means starting small.

Once we got through the buyer to the consumer, both the stretch boot and the crepe sole wedge spread like a grass fire. The stretch boot was difficult, and I remember trying to get some in one important store in New York. They finally allowed me to send a few trial pairs up; but they sent them back. One pair got lost. A lady found them, put them on, and would not take them off. That pair spread the news like wildfire through the city. The other day I said to Herb, "I have an idea that I think would be as big as the boot for the shoe industry." He asked me quietly, "Are you sure you want to go through that again?" That is the way it still is in the U.S. Ask any designer about cooperation from the industry before an idea becomes an accepted fact, I asked a few before I came, and it seems it is even worse. They all say, "We just have to work around it. We do not even bother asking for the development of materials we need any more."

I have cited a few illustrations of the way a designer works. A designer cannot work in the abstract. The designer must anticipate the future needs of the consumer, of society itself, and of the marketplace. The designer needs the technician for the implementation of an idea to make it practical and workable.

Let us uncover our Achilles' heel and learn how to work together. We must face facts. Some of our shoes are marvelous, and some are terrible. We should adjust our standards, and stop the excuses. How can our technologists help? As you sow, so shall you reap. In the timing of style and design changes for manufacturing and delivery, you will have to adjust your thinking to modern times and be able to change directions quickly. If open shoes are desirable, make them good and stop complaining. Establish a factory attitude that flexes with the times. It is just as easy and takes the same time to do something well as half well. Isn't it a shame that our country practically gave up on the sneaker just when it was becoming the greatest? The jogging shoe, the basketball shoe, the working dentist shoe, and the shoe cutter's shoe are some examples. To be big is fine; to become obese so you cannot move is another thing.

I keep thinking of the brilliant shoe engineer working for one of the machine companies who told me, "A manufacturer calls me and asks 'What's new?' I say, 'I have something.' They say, 'Come right over.' I do, and they say, 'Who are you making it for?' I say, 'No one yet. That is why I am showing it to you'. They say, 'Come back when you are making it for somebody else.'" That's a true story.

The United States is really the biggest common market in the world. We are the biggest exporter of shoe ideas in the world because we have the capacity of our voracious market to buy the pairs. Don't all shoes, except sports and athletic shoes, look outmoded to you? In this nation of the Moon Walk, Edison, the Wright Brothers, the computer, and the automobile, don't our shoes look like the 1940's and 50's?

Computer stitching is brilliant and exciting, but the needle must still be threaded in the old-fashioned way. Flow molding can make soles and uppers, but our thinking is only to put the process into the cheapest form of footwear without developing it as a superior technology. Do you remember when cemented shoes were considered the bottom of the barrel, and not to be used by anyone except the cheapest? Now it is <u>the</u> method.

I would also like to remind you that there are fine leathers that technologists could be working with in conjunction with new processes and molds. If you are trying to do something that has the feel and look of leather, why not have a frame of reference of good leather so that your technicians can understand what it is. Why not have a frame of reference of anything good? Quiana was great because they <u>tried</u> to make it the best way, not the cheapest way. Do you remember when cotton was supposed to be cheap, and now pure cotton is as expensive as silk and more desirable.

A classic current case is the injection-molded fisherman sandal. It can be produced profitably for $2.00, and can shod the world. But we did not respect it, until it was copied as a high fashion sandal from Paris. You wear the shoes in our mobile world; you do not wear the machine or the label. But our industry is so slow to react.

New products and new habits make new markets. The time is now for a new beginning, before it is too late. The manufacturer and the technologist must close ranks. Where injection molding or flow molding machinery is too costly for one, perhaps there can be some kind of contracting. Where the idea is new and the retailer is wary, there must be some ingenious method devised to reach the consumer to test the new idea. The little guy who thinks and acts creatively must know where to go for technological knowledge. He is the one who introduced the automatic transmission and bakelite for example, the accepted advances in our society today. The successful creation of a Footwear Technology and Education Center in the United States is of the highest priority, and I am glad to see this being pursued as an important ingredient in the revitalization of the domestic footwear industry.

We must learn to give the consumer shoes for a myriad of activities; shoes at prices the consumer can afford to pay; and shoes that are comfortable, so that even Los Angeles may learn to walk again, and save energy, too. We must give the American manufacturer trained workers. We must give the workers trained foremen who can teach them to make it better.

For the technologists, I would like to leave you with this story. You know there is a glass that is stronger than steel. A Corning Glass scientist was called in by the company head who said, "You know we make glass?" Bewildered, the scientist responded "Yes." The head man said, "Glass has certain properties. It is inert, it is translucent, it can be colored, shaped, textured, and now it even withstands thermal shock." "Yes." "But, there is one thing wrong with it. It breaks. Now fix that."

Questions And Answers

Q: You say that the industry is not very receptive to your ideas. Can you tell us why this is so?

Levine: A new idea shakes everyone up. Some people get nervous, and some love the idea. As a country we are so fat, and we think that because we made it, they have to buy it. Others have proved that while we were sitting saying how smart we are, they could do it better. I know some of those markets. I was there, I helped. I sent patent leather to custom makers in Europe, American patent leather was the best. They did not even make it any place else. They finally made it well in Mexico too, because they would not even make the colors here if you wanted a color. They brought the machinery to clean the air in Mexico City to make it good.

Comment: You talk about the industry being fat. Domestic industry has not been fat for some time, and it has been very upset by imports and other problems. I am the only independent shoe retailer in this room, and I think more should have been here. It is our fault. I also think there are a lot of manufacturers who should have been here. I am proud of the people who are here. I know what a great service you and your husband have done to the industry, and I only wish that there were more of you. However I do not think that the problem now is fatness.

Levine: I am sorry if I made that point upside down. I said we <u>were</u> fat. Right now our industry is a little better in certain parts but only because of the tremendous inflation in Europe; that has become the factory filler here. I am here only to face facts. I am not asking for signs of the closing of business, as you know, but I ask you, as an American retailer, would you accept newness easily? I hope so. Well, I think we here in America owe it to the world to do something new in shoes.

Q: What new ideas do you see on the horizon?

Levine: If we're interested in real, real newness, and something that has not yet been tried and proven, why don't we do this - develop a shoe that we can just step into and have lock around the foot? I think there is much yet to be done, especially with the flexibility of soles and with body movement. Why not try?

Q: Would you care to comment on how we might train young people who come into the shoe industry to be more fashion conscious?

Levine: If you want them in the shoe business, then make it attractive and self-respecting. A lot of people love the shoe business. A lot of young people are attracted to it, and if you make it available to them, they will be there. Also, shoe companies should take advantage of the natural resource in women's shoes by employing women someplace. That would be a very practical beginning. When I was hammering on the business of the leather insole, I think that most of you did not know what I was talking about, but a women would.

Q: Is there a danger that some of the new fashions only cater to a whim, that are very extreme fads, and are extremely unfunctional?

Levine: Although there are some extreme fashions today, they won't always be considered that way. Some of the shoes that are accepted weren't accepted 30 years ago. Open-toed shoes used to be called hooker shoes in the 1940's. Open-toed shoes were a revolution. They were in bad taste, but today they are top fashion. There have been more revolutions in shoes than any other part of apparel. Diana Vreeland, the head of the Costume Institute of New York and the high priestess of fashion, says that the two most important fashion innovations in this generation are the blue jean and the boot. But you asked about function. To me function is comfort. The shoe is what the foot is most sensitive to. To the industry, that's a blind spot, but not to the consumer. The shoe can cause discomfort and unexplained distress. Shoes should feel beautiful on the inside as well as the outside. This point has been proven by the success of the boot.

The boot is interesting, not because of the fashion, but because of the feeling. The first time I did a high-heeled leather boot, I had this beautiful leather I could not stand to cut, so I made it into a seamless boot. It was comfortable, even though you had to pull the boot on. The last boots I made had the lightness of weight and the comfort of a nylon stocking. I believe that the boot in some form will always be in style because it is comfortable and a bad leg can look good in it.

Q: What is your personal thought of the possibilities of computers in designing? Do you think in the future that it might be of great help in inventiveness?

Levine: If you can get something done faster and you can see it faster, that would be a help, particularly if it can give you this tri-dimensional perspective that we need in shoes. As you know, we work upside down. Sometimes a designer can do something in a flash and sometimes it takes months to develop. Anything that can speed up the process and keep the creative activity going would be marvelous.

Dr. Wolek· Thank you, Beth for a delightful presentation. It confirms one of the basic philosophies that has underlined our whole approach to technology. Technology is not a machine we can just install in the factory, press a button, and get reduced costs and the increased sales. There is going to have to be some very hard work to couple the technology with the market strategy for each product line. We may need to change the way we work with retailers, with consumers, and with each other to provide the value that justifies the cost of and the commitment to American manufactured products. I am pleased to see that there is a spirit in this group to move forward and examine various technologies as they tie into the whole corporate picture. In conclusion, we must define some specific steps for our future well being.

SYMPOSIUM INTEGRATION AND FUTURE DIRECTIONS

Dr. Jordan Baruch

Assistant Secretary for Science and Technology,
U.S. Department of Commerce

My purpose in this wrap-up session is to integrate the important aspects of our discussions yesterday and today as well as to chart the course of our future actions. To help in this task, I have just spent a couple of hours being briefed by the working group leaders on your discussions in all ten parallel groups. Let me share some of my own feelings, then I want to hear your questions and comments on our two days of discussions.

One of my biggest concerns is the natural slowness with which the Federal Government moves; I know many of you share this concern. But there are things we can do about that. One example is in the development of a footwear center. I know uppermost in your mind is the establishment of a footwear center to focus upon the development of the basic technologies and services on which your business depends. Dr. Wolek already told you this morning that we agree with this goal. Moreover, we will remain alert to actions we can take to make the process of establishing the center move as fast as feasible. Although the necessary and detailed planning will take some time, we in the Department will do everything we can to make sure the timely availability of needed resources acts as a stimulus rather than as an impediment to the process. This may take the form of earmarking parts of existing funds or, if necessary, to request a supplement to our budget authority. The point is that we want to minimize the effects of artificial fiscal calendars. I have already spoken to the Under Secretary on this matter and I have his full support.

We are going to need help from you in the form of substantive thinking. We will need the advice and review of knowledgeable footwear industry people in making the planning and allocation decisions that we are required to make. We will need advice on the functions and structure of the footwear center as well as on the technology needs of the industry. We will need the ideas of the most resourceful and innovative representatives of all parts of the industry - shoe manufacturers, suppliers, equipment manufacturers, retailers, and organized labor. These will be working groups, not study groups. Therefore, I make an urgent request of you today, to send nominations of such industry representatives to me directly. Let me give you further examples of what I believe has to be considered and the role of the industry in this process.

At lunch today the working group leaders told me their members said: "We need help in the fitting room, we need to consider the questions of three dimensional stitching, we need people to address the flexibility of set up and change in the fitting room. We are particularly concerned about transferring goods from one machine to another and handling goods as they pass through a machine. We want help in the whole CAD-CAM area".

One of the characteristics of computer-aided design is that once the basic information is in the computer, there is no end to what you can do with it-from inventory management to factory loading. However, each of those applications takes a lot of effort and money. It also takes education of the people who will use it. Clearly, a center such as the one we are talking about has to not only be concerned with research and development, but also the actual transfer of the new capabilities that it generates. Technology transfer will be a critical part of the center responsibilities.

In reviewing research centers and collaborative programs in Europe and Japan, we learned that there has to be not only an interest on the part of industry, but also an active involvement on their part in selecting and evaluating the projects in such centers. Otherwise, you will have a new research institute doing all sorts of interesting things, but without having much actual impact. That would not be a good place for the footwear industry to be right now. You need help on directly applicable things. We also need industry participation because the government is going to be cautious about spending other people's money for helping a specific industry. What they are going to need is a demonstration that if we do "A", the potential payoff looks like this, and the impact will be thus and so on our balance of trade and on the small companies, and the medium companies, and the large companies.

The only people who can generate that kind of knowledge come from the industry. Therefore, unlike most government activities, we are going to insist that the individual projects be guided by industry people. There is some difficulty with that when you start getting industry people on a CAD-CAM project; although they can visualize the use of it to a limited extent, they also need the opportunity to interact with well-trained technical people. That we will provide. We will contract for it where it is appropriate or provide you with Department staff when that is necessary. We will also get you the equivalent of a technology marketing person, somebody who can explain the meaning of the technologists' ideas to you, the users. The best development organizations in industry work like that. They have transfer people to work between the management and technical people.

When I say I want a nomination of candidates from you, I want very special kinds of people. I am not particularly looking for manufacturing engineers or industrial engineers, but rather people who have to make decisions in the company. The major decision makers must be involved and that includes chief executive officers and vice presidents of marketing from all sizes of companies. I would like some input from the retailers and from the equipment manufacturers. From those nominations we will then try to form a representative committee. Normally in something like this, the center would engage in this process with you. My hope is that once we have got a center established, most of the development activities you are interested in will be performed there.

In the meantime, I do not think we should wait for the Footwear Center to get established and operational before starting some of these projects. As soon as these committees can get formed and interacting, we can then seek standby technical research and development assistance. If we need CAD-CAM help, the shoe industry may end up contracting with General Motors or MIT or other specialists. We want to get research activities started. I would like to briefly discuss a list of projects that the discussion leaders spoke to me about at lunch and get your reactions. I would also like to get your reactions to the scheme that I have proposed to organize. And I would like to get your reactions to the whole approach that we are taking.

I mentioned the need for help in the fitting room, CAD-CAM, and computer aids for management information. These three are inseparable. Computer-aided design leads to things like rational inventory control, material requirements, inventory control systems, shipping schedules, procurement schedules and preplanning. They could go together into a computer-aided shoe manufacturing project. One thing that did not come up was OSHA. For example, the industry is going to require help in the noise control of its equipment. Adjusting to any such regulatory requirements are one reasonable place for us to participate with you. The last item that came up at that meeting was bonding and adhesive systems, which is of perpetual concern to the industry.

This is a good point to respond to your questions and comments.

Questions and Answers

Q (Norman Germeny, AFIA): The computer-aided design conversation did not appear to me to go quite far enough into the method of last making, which has the special problem of still being primarily an artisan approach.

Baruch: I agree we should look more into last making. If you are going to get into shoe design, the sorts of things that you put into the computer first are constraints. For example, if you have an assortment of lasts, you can store them in computer memory and move the shoe design to any last and the computer can test the fit. However, there is another step. If you have a shoe design that does not fit an existing last, it becomes important to be able to use that same digitized information as an input to the process of last patterning and last molding. If we look at this production process as a whole system from beginning to end, we, especially the committee, will recognize where the bottlenecks are.

Q (Narminder, Kapany, Kaptron, Inc.): The concept of the Footwear Center is a very exciting one. The industry is in trouble; therefore, the need for an agency for solving problems is realistic. However, when the going gets rough, will the first thing to go be research?

Baruch: That is just the sort of thing that our studies and the center advisory committee will have to address. In our studies of productive laboratories in industry, we find the discretionary or bootleg fund of a laboratory ranges from 15 to 17 percent. A bootleg fund is money given to someone who has an unusual idea. That kind of bootleg money turns out to be among the most productive money spent in an industrial laboratory. Many companies have a fixed figure in their budgets for this. Hopefully, the center would have the same kind of flexibility.

Q (Tom Bleasdale,USM): I am going to ask a more fundamental question. Dr. Wolek described the center in terms of research and development. Fred Meister emphasized education and other similar responsibilities for this center in addition to helping in technology and research. I represent the supply sector for the footwear industry, which like the shoe manufactureres, has suffered due to shoe imports. This afternoon, you spoke about this center more as a research and development center. Can you find a balance between an educational center a capability to use high technology, and a fully fledged R&D center? This is a small industry. If we are eventually to fund this center and it gets into expensive research and development programs without sharp marketing input, then the industry will not be able to afford to support it.

Baruch: Absolutely. If I did not mention the supplier industry, it is because I lumped them with machinery people, and that was a mistake. Clearly, there are many suppliers in the industry. Paul Olsen's study of innovation in the textile industry showed that over 90 percent of the innovation in those businesses came from the suppliers of those businesses. A major thing that such a center can do is to prepare the firms to absorb the technology. One of the major difficulties in this is education. The center committee will investigate what kind of a center is appropriate for the shoe industry. Perhaps you will ensure that suppliers are represented in that slate of nominations I requested.

Wolek: I can understand your confusion. A footwear technology center would provide the education and services you want. With that type of capability established, there will be a technical know-how available for doing research and development. That research and development can be supported on a project basis by the government. There is no difference then between what we are talking about. There is still an important issue, however, of the kind of research and development that will be done. The R&D we contemplate is in an area Dr. Baruch calls infratechnology, and it is the type that supports suppliers, rather than sets up a government-assisted competitive network to the supplier.

Baruch: If we look at the technology structure in the United States, we find that basic research is generally very well done by universities. Development of new products and processes is well done by industry. Government has a role in the research area where no industry can support it alone. Government has essentially no role in the development area, except when it is the development of something the government wants to procure. There is an area between these two that I call infratechnology. By infratechnology development, I mean the basic technologies on which industry builds its new products and processes. When I said a center like this might work on adhesive systems, they will not compete with manufacturers because they will not provide adhesives to the shoe industry. They could work on projects such as investigating those kinds of adhesives or adhesive combinations that would eliminate pre-roughing. That information then becomes available to the members of that center, those supporting it on a regular basis. Presumably it will be incorporated into the new products of the suppliers, if it is useful. To me a technology center should provide the kinds of services that were provided by the most successful ones I saw in Europe.

The best ones I have seen in Europe are organized as follows. They have a governing board made up primarily of industrial representatives, along with some government representatives. The main purpose of this board is to define project areas with the help of the technical members on the board and technical staff. They select the set of projects that will have significant impact on that industry. Money and guidance flow from the industry to that center. The government also provides funding, but generally to support specific projects in a customer-buyer relationship. The government's choice of a project is different from industry's. The industry may pick a product on one set of criteria, while the government in general will ask what social benefits accrue from that. Does it increase employment, does it increase our balance of payments, is it anti-inflationary? The projects the government does not choose to support are supported primarily by the funds that flow from industry. Generally there is a flow of funds on some matching level. You might, for example, start the Federal share at a 75 percent level the first year and drop to nothing in five years. We found a wide range of that kind of thing.

What does this type of institute generate? The best ones we have seen generate three benefits. One is planning for the industry. It looks at where the competition to the industry as a whole is growing and plans activities to benefit the industry over a longer range time horizon than is usually used by planning executives in individual firms. This effort represents typically about 10 percent of their total funding. Another thing it does is research and development. It actually works on the development of that infratechnology we discussed. This represents 45 percent of their funding.

The last and most important activity that most of these institutes engage in, using about 45 percent of their funding, is a combination of consulting, education, and technology transfer. The consulting activity is not done for the whole industry, but for an individual firm. That work is paid for by fee by the firm. The firm specifies the problem and hires the people, generally those who have been working directly on this infratechnology development. They help in consulting. In technology transfer, there is a similar process, usually directly with the suppliers to the industry. They do a market analysis of their own industry for a new technology and then go to the suppliers and get them started on the product development needed for the technology. The education activity, also paid for by the firms, is a general ongoing activity that includes collecting the best technology available to the industry, providing it to the users, and teaching them how to use it. It is essentially the function that a library and educational group play together in a good industry.

Some of these have both extensive publication systems and a below threshold consulting system, where so many hours are available to any member free for consulting activity. Incidentally, probably not all the firms in the industry will be supporting members of this center, because it takes money and it may take people. In England and in Sweden they charge a differential price to members and nonmembers for consulting and transfer activities. Also in England the new infratechnologies become available to the members continuously. They get progress reports; nonmembers get only a final report. The reason that nonmembers get any information whatsoever is because part of the funding comes from the government. One of the things you will find as we work together on the design of a U.S. footwear industry center is that the big concern of the antitrust division is who cannot participate and receive the benefits of such a center. This is the kind of paradigm we see in other industries and nations. I have no idea whether it is appropriate for the shoe industry. But if it is not, I would like to hear about it.

Q (Tom Bleasdale): As a supplier, we have spent more than 4 percent of our volume on research and development. We have a lot of the technology to do some of the things that are required, but the expense of the development costs for a relatively small industry did not justify us continuing beyond the model stage. I believe new technologies are not necessarily absent from the suppliers; the fact is that we are dealing with a relatively small industry. There should be some way this center could assist the suppliers in applying the technology they have developed.

Baruch: The problem is that each group has their own view or solution to a problem and each has its place. Government bureaucrats should not decide which is the appropriate route for the shoe industry. My hope is that each group or their representative on that board would push for their idea until a decision is made. Another approach you might take, however, is to go to the government and say, "Look, this is too much for us to tackle, and yet we see this as a useful approach in many areas. Does the government want to participate in funding us directly?" When you do that, you lose part of your exclusive patent protection. That is the kind of management decision you have to make.

Let me go one step further with the supplier question, if I may. This is only one center. One of my current dreams about this approach we are taking is that there will be many such centers serving other industries. When I testified to Senator Stevenson, I pointed out that the work we are doing with the shoe industry is a paradigm for the work we may be doing with the computer industry five years from now. In Japan the government and industry together are investing $300 million in large-scale integrated circuits, $100 million in flat-screen television display, and $40 million in fiber optics. Those things pay off.

Over the next few years we must realize that this country will be engaged in a different kind of war than ever before - an economic war. Unfortunately, the people we have to look out for are our friends.

One thing I would like to see in these American industrial technology centers is an effective communication link. If we can get these centers working together, we could get an additional function in this footwear center, that is to coordinate with the other centers so that needs can flow across industries. That sort of interaction between industries needs to be institutionalized in our society. Thus, I see the shoe center as vitally important to you, but also to other parts of the economy. For one thing, if we develop demand for a product that is too large for the shoe industry to work on, it may well not be too large for a wider range of other industries. Knowing USM, I know they do their marketing homework in the textile business as well as the shoe business, but this should be institutionalized at a level where others besides United Shoe Machinery can have this breadth of vision.

Q (Graham Butlin, SATRA): I would like to comment on the British research associations. The potential danger is that if you hire a research association that has a high proportion of its income coming from membership fees, you will find that that research association normally offers virtually nothing to nonmembers. Research organizations that are highly contract research oriented, and who have a lower proportion of their total income coming from membership fees, do in fact have a two-tier system of charging. There will be fundamental problems of attracting members who want to know what they will get back for their dollar. If they are expected to contribute to fairly large central services covering a wide spectrum, they are not going to do it, if they can get the answers without joining.

Baruch: The problem will be how do we balance what goes to the members, versus the nonmembers? If it turns out that everything has to go to everybody at the same time, then it is going to be a government institution. If it turns out that only the members can get the benefits, it may be a pure membership institute. The Monopolies Inquiry Board is much more relaxed about the RA's in Great Britain, but ours has not had that same 32 years of experience. We have a different problem in the U.S. We have to make something available to nonmembers, and we have to provide differential availability to members that warrants them taking the investment step. That is part of the planning process that this committee will have to work on, and that is why both industry and government should be represented on the committee.

Let's not ignore the antitrust issue. It is legal under the antitrust laws in this country for any group of companies to get together to do research, provided they do not suppress the results. However, no legal counsel of any company will tell his president that it is alright to do it. Companies are very sensitive about this in this country. It is not just the law that is involved, but also the perception of the law. We want the antitrust division to join us in the creative stage, help design the system, and give us a "no present intention to prosecute" letter, that says the design fits our antitrust laws, before we get the companies involved.

That is part of what is going to take time in getting such a center set up.

Q (Jacob Rabinow, NBS): In your model what is the amount of funding needed, both from industry and the government?

Baruch: Well, that is also going to depend on the industry a lot. The RA's in England and Sweden are funded roughly 50/50, if you look across the whole spectrum of them. Some of them are heavily funded by industry and lightly funded by government and vice-versa. Dr. Wolek talked about an initial government involvement of 75 percent in the first year, dropping to 0 percent in the fifth year. That is also 50/50 integrated over five years. I worry, however, that in that system the center might change when it became entirely industry. It might start working on things that are not socially interesting or start excluding members and get in trouble with the antitrust division.

The total funding varies greatly, but you want a budget that matches the task. One reason we will have these committees is to look into the task to determine the payoff and its cost and to determine the interest of the industry.

Comment: I think there is a danger in what we are doing. You might get a large board of people contributing enough time and money, but when it comes to a supporting situation, they might sit back and just watch the people who are paying money for a structure that might not suit them. That is a danger in the formation of a center based on people that are not committing themselves to supporting it.

Baruch: Absolutely. We will also not take the results of the committee as the final structure of the center, but rather as a starting point. The RA's in Sweden had the industry form the foundation, get the members, and put money into it, and then they neogtiated with the government. My only concern about the initial structure is to pin down government-type problems, like antitrust. The actual organization of the center, I'm sure, will be largely left to the members of the board, who are in fact the representatives of the contributing corporations.

APPENDICES

Contractors' Reports and Participant List

INNOVATIVE APPROACHES IN TECHNOLOGY AND PROCESSES TO AID THE SHOE INDUSTRY THROUGH THE TRANSFER OF TECHNOLOGY FROM OTHER INDUSTRIES

Report to

NBS Shoe Team

U.S. Department of Commerce

May 15, 1978

C-81706

Arthur D. Little, Inc.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

INTRODUCTION

This report covers the work conducted by Arthur D. Little, Inc., under the direction of the NBS Shoe Team, U. S. Department of Commerce on Purchase Order No. 808207. It presents the results of our findings with respect to innovative manufacturing technologies applicable to footwear production considering the potential transfer of technology from such diverse industries as nonwovens, pulp and paper, electronic circuit board, and plastics.

OBJECTIVES

The specific objectives as stated by the NBS Shoe Team for the studies involve innovative approaches in technology and processes to aid the shoe industry were stated as follows:

"To identify current and/or advanced (within five year spectrum) manufacturing technologies which singularly and/or in concert could impact the production process of the U. S. nonrubber footwear industry;

To quantitatively evaluate the benefit these technologies could provide domestic manufacturers of nonrubber footwear relative to foreign footwear producers; and

To identify areas where cooperative efforts between government and industry are appropriate for developing needed manufacturing technology or facilitating the use of existing manufacturing technology."

APPROACH

In carrying out this work internal meetings were held among our staff who consult in these industries. The team consisted of five core members and 15 industry oriented members. Following the initial transfer of technology sessions, the core team evaluated the suggested concepts for developing a more cost effective footwear industry. As a means of attesting the practicality of our concepts, we contacted and held in-depth interviews with shoe and shoe machinery manufacturers.

Our findings indicated that significant advances in technology could be made utilizing transfer of technology with respect to:

- Shoe upper manufacturing techniques
- Shoe upper materials
- Mold design and manufacture

CONCLUSION

Our conclusion is that the U. S. shoe industry to be viable as a manufacturing entity that can compete worldwide will have to develop technology to go directly from raw or processed bulk materials to finished or near finished footwear. The industry has demonstrated the capability of manufacturing shoe bottoms successfully but not shoe uppers using this principle.

FINDINGS

We believe there is potential for the transfer of technology to the shoe industry for the following processes and principles from the industries presented below:

1. Nonwovens and pulp and paper industries.

   - Hydraulic needling
   - Vacuum deposition and forming
   - Electrostatic spraying
   - Dipping

2. Electronic circuit board manufacturing.

   - Electroforming
   - Vacuum plating
   - Masking

3. Plastics industries.

   - Reaction injection molding of poromeric materials
   - Liquid injection molding
   - Dielectric and high frequency joining techniques
   - Electron beam holing
   - Laser holing
   - Fibrillation through the use of blowing agents
   - Shrink wrapping

4. Other

   - Dilatency principle applied to mold making

I. INTRODUCTION AND BACKGROUND

Our program with the National Bureau of Standards Shoe Team, U. S. Department of Commerce under NBS, DOC Purchase Order No. 808207, was to carry out a series of in-house technical meetings using Arthur D. Little, Inc., experts in the areas of nonwovens, paper and pulp processes, electronics circuit board fabrication and plastics fabrication processes, to determine if it was possible to develop innovative approaches from these technologies and processes which could be transferred to the manufacture of shoes. An additional requirement was that the cost effectiveness of such techniques should be investigated and that any recommended technologies and approaches be such that they could be adopted by the shoe industry within a 3-5 year time frame. This report, in conjunction with our attendance and participation in a seminar to be held on June 1 and 2, will conclude our participation in this phase of the program.

Our work in the program began with a briefing at the National Bureau of Standards on March 23, 1978. Arthur D. Little, Inc., was one of seven firms selected for this program. At the briefing information and background data gathered by the NBS Shoe Team under the direction of Ms. Margery King was presented. These data consisted of trip reports on interviews held with shoe and shoe machinery manufacturers and the American Footwear Industries Association (AFIA). Some significant aspects of these data with respect to our program were the percentage distribution of costs for an average shoe. Seventy-five percent of the shoe cost is materials and labor with the ratio of costs of materials to labor being 2:1. Of the labor costs, approximately 75% is expended in cutting, fitting, stock-fitting and lasting of the upper. As a result of these observations, we focussed our attention on ways to effect innovative techniques and materials processes for reducing both materials costs and labor in forming the shoe upper.

II. NONWOVEN TECHNOLOGY

In the nonwoven technology area, our internal meetings resulted in suggestions for several opportunities for innovating shoe manufacturing techniques based upon the utilization of nonwoven manufacturing processes and/or materials. An advantage of nonwoven technology is its relatively low material production cost compared to textiles. There is also considerable variety in the types of finished goods which can be obtained. For example, webs with various degrees of fiber orientation, controlled porosity, and low bulk density can be built up by appropriate fiber deposition methods. The webs may be subsequently matted, bonded, and formed into shoe components or substrates for further finishing.

The processes used to produce nonwoven roll goods are as follows:

- Dry processes in which the fibers are carded or air-laid to form webs which are then bonded with polymeric binders or needled to impart strength.
- Wet processes in which webs are formed from aqueous dispersions of fibers by papermaking techniques. Binders are incorporated during or after web formation.
- Composite processes in which scrim, fibers, or foams are laminated with tissue, film, or nonwoven webs.
- Spunbonded processes in which webs are formed by in-line melt spinning and deposition of fibers.
- Spunlaced processes in which fabrics are produced by hydraulic needling of deposited fibers.

Most nonwoven fabrics are produced by dry processes, especially carding. Spunbonded fabrics are the second most important type of nonwoven. Presently, nonwovens are used in the manufacture of coated, impregnated, and laminated fabrics for shoe uppers, inner components for shoes and boots, etc. Pellon Corporation in Lowell, Mass., for example, manufactures nonwoven interlinings for the shoe industry. Almost all man-made poromeric products have been based on a needled nonwoven substrate layer of one type or another. Some of these, such as Corfam, have also had a woven polyester/cotton or cotton fabric layer. Generally, the types of fibers used are polyester, nylon, rayon, or polypropylene either alone or as blends.

Most poromeric materials utilizing a nonwoven substrate follow a typical manufacturing process:

1. Nonwoven web formation (specialty fibers may be used);

2. Impregnate with a binder to form a structural web;

3. Coat the bonded web;

4. Treat under conditions which, in conjunction with specially formulated binder and coating used in steps 2 and 3, develop porous structure; and

5. Apply color and surface finishes.

From our internal meetings, several suggestions were made for using nonwoven technology or materials for making shoe uppers:

- Deposit staple fibers suspended in air on a porous last, consolidate and impart integrity to the preform by hydraulic needling, then treat by steps analagous to 1-5 above to produce poromeric upper.

- Deposit staple fibers suspended in air on a porous last, consolidate and spray with binder, then dip coat with vinyl plastisol.

- Develop or use synthetic leather in roll goods form which can be bonded by ultrasonic energy or dielectric heating techniques to form uppers. This type of bonding would replace the labor intensive stitching operations currently used.

- Injection mold an upper and apply flock to develop desirable aesthetics.

III. PAPERMAKING TECHNOLOGY

Papermaking technology is used to produce a number of shoe components. A good example is "Texon" inner sole material produced by Texon, Inc. "Texon" is made by impregnating a heavy paper or board with polymeric binder to impart the desired performance properties. Wet-laid nonwovens are produced on paper machines using blends of wood pulp and longer synthetic fibers. Technology is also available for dry forming paper and related products by depositing the fibers from an air suspension.

Papermaking technology also encompasses pulp molding, an operation in which the water suspension of fibers is deposited on a porous mold to produce preformed shapes. Egg cartons and a variety of protective shipping containers are examples of pulp molded items.

A concept proposed during our internal meetings was to form the shoe upper by an adaptation of the pulp molding technique. A blend of wood pulp and synthetic fiber would be deposited from a water or air suspension onto a porous shoe last. The last might be made, for example, from metal or plastic screen. The deposited fiber mat could then be impregnated with a binder, and subsequently cured, or dipped in a vinyl plastisol, or sprayed with a urethane coating.

Another way of forming the finish would be to use a shrink wrap such as a vinyl chloride or pigmented polyethylene on top of a pulp which was molded with an adhesive binder.

An example of a product formed using pulp and paper process techniques is one which we developed using ground leather fiber with an elastomeric binder that was dry-formed into a poromeric sheet. This dry process could be adapted to three dimensional upper formation.

IV. ELECTRONIC CIRCUIT BOARD MANUFACTURING TECHNOLOGY

The manufacture of electronic circuit boards utilizes a variety of wet and dry processing steps such as coating, chemical etching, photo lithography, silk screening, plating, etc., to develop the electronic circuitry. The objective was to identify techniques which could be used in the creation of various designs for shoe uppers resulting in improved productivity and styling. We found that the processing techniques used in this industry, although potentially applicable in obtaining the detail necessary in the design of shoe uppers, would not be cost effective in the shoe industry. Other suggestions which came from this technology involved the use of electroforming to obtain minute detail on mold surfaces. Electroforming is used extensively for production molds at this time. Vacuum plating and masking techniques as practiced in the electronics industry may also be applicable in the manufacture of molds with special surfaces or effects.

V. PLASTIC MOLDING AND FABRICATION TECHNOLOGY

The various types of plastic molding and fabrication technologies which were considered include:

- Sandwich molding;
- Two-shot molding;
- Hot stamping and warm forging technologies;
- Blow-molding combined with injection molding;
- Reaction injection molding (RIM);
- Low pressure liquid injection molding; and
- Non-sewing joining techniques such as ultrasonic, dielectric and high frequency heating methods.

Many concepts were proposed for making shoes and/or shoe uppers using non-conventional plastic molding techniques including sandwich molding, two-shot molding, stamping technologies, and/or blow-molding followed by injection molding. However, the problems associated with mold design and fabrication and mold costs using such techniques indicated that they would not be economically feasible for shoe manufacture. The possibilities of using the emerging RIM technology and/or low pressure liquid injection molding, however, were intriguing, and the approach was therefore explored more fully. It was determined that the RIM process might be adapted to shoe manufacture in several ways. One approach would be to utilize the so-called RIM process for molding a complete shoe upper (with or without a fibrous substitute) from a relatively low-density polyurethane composition. Another approach would be to use the same RIM process for the liquid injection molding of the upper section of shoes as two separate components which would be subsequently joined by non-sewing thermal techniques. A very flexible lightweight urethane could be used in the process and porosity might be obtained by needle punching which would produce a continuous path through the structure for breathability. Electrobeam holemaking or laser holemaking are two other methods that could be used for producing pores in the molded upper. The RIM molding technique could also be used to apply a molded coating over an integral nonwoven inner lining and other fibrous reinforcing parts located in the heel and toe areas as required for stiffness and other properties.

Other techniques were suggested for making fibrous substrates which would be less expensive than through the weaving process, and in some cases, even cheaper than knitting. The first of these involves the use of plastic sheets such as expanded polypropylene which when stretched and fibrillated forms a nonwoven substrate. The second process utilizes slit fibers which, if appropriately done using appropriate geometric patterns, can be formed into wovenlike structures.

Another process, which was suggested for making shoe uppers, utilized an adaptation of the process used to manufacture porous fabric reinforced vinyl gloves. In this process porous vinyl coatings can be produced utilizing extractable media or air in the plastisol. In adapting this process to shoe manufacture, one would first use a substrate consisting of a knitted sock which would slip on a conventional last or deposit a nonwoven substrate on a screen or porous last. The lasted substrate would be dipped in the vinyl plastisol formulation to build up the desired coating thickness. Subsequent fusing and extraction of the formed piece would result in a porous, breathable structure. To obtain an embossed three-dimensional surface, however, one would have to use a female mold around the coated last prior to and during the fusing of the plastisol. A RIM type of system could also be utilized with the vinyl plastisol injected around the knitted sock on the last (male mold half). This would be a low pressure system where the major adaptation of the RIM process would be in the high speed injection techniques.

VI. INNOVATIVE APPROACHES TO SHOEMAKING

Two significant approaches to the making of shoe uppers going directly from bulk processed materials to the near finished shoe have resulted from the amalgamation of several technologies; namely, nonwoven, pulp and paper, and plastic.

A. Dip/Spray, Gel, and Fuse Approach

This process would require a last (male mold) over which a substrate can be applied if a lining is desired; namely, a knitted lining which can be easily pulled over the last. Other techniques to provide a textile substrate would involve the deposition of a nonwoven fiber built up by a vacuum or electrostatic deposition on a special last. If a textile lining is not required, the bare last would be used for the depositing of the porous shoe upper material. A vinyl plastisol would be deposited on the bare last or textile covered last by either spraying or dipping, or a combination of both techniques. The vinyl plastisol would be made porous utilizing known technologies involving extractable additives. Thickness would be controlled by the amount of dip or spray. If desired, preformed counters and box toes could be placed on the coated textile lining material prior to dipping or spraying. Once the required thickness is built, a female mold would be used to provide the outer surface finish in the final plastisol fusing process.

B. Direct Molding Approach

Utilizing either RIM or low pressure liquid injection, this second approach is the preferred method of going from bulk processed materials to the near finished shoe. The last (male mold) can either be bare or have a textile liner cover as described in the first approach. The molding technique would be to use RIM or low pressure liquid injection molding with either polyurethane or a vinyl plastisol resin system. Either of these systems require relatively inexpensive male and female molds since the pressures are low. In the case of polyurethane, the technology already exists for the molding of porous urethane shoe uppers and samples are available from the USM experimental program. This process is covered by United States Patent 3,668,056 dated June 6, 1972, entitled "Integral Microporous Article and Process of Making." The abstract of this patent follows:

> "A one-piece microporous clothing article such as a shoe upper or glove is formed by molding a solidifiable liquid emulsion of fine droplets of an organic liquid in a continuous phase comprising reactive material convertible through reaction to solidified resilient condition. The emulsion is caused to gel and solidify with said droplets held in the solidified material. The solidified material

in the form of a shoe upper or glove is removed from engagement with the molding surface and the liquid is removed without expanding the solidified material leaving pores and discontinuities in the solidified material to constitute passageways for air and vapor."

A porous upper could also be made by a low pressure injection molding system using a liquid vinyl plastisol containing extractable additives.

The industry practice for making inexpensive low pressure molds involves the making of a rubber production master on which can be deposited a metal shell by spraying a liquid metal or by spraying using an electric arc gun or more conventionally by forming the shell using electroforming techniques. These shells are backed up and supported by a filled epoxy resin compound.

Another approach to a low cost mold for the manufacture of shoe uppers would be applying the principle of dilatancy. Dilatancy could be used in the production of the rubber master depending upon the level of detail that can be achieved. The dilatancy principle involves the use of a flexible elastomeric bag which contains fine shot. The bag is formed about the master male pattern which would be the last and is made to conform to it. Then a vacuum is drawn on the bag freezing the shape and detail of the master. Through an applied research program this mold concept may evolve into a highly mechanized, inexpensive method of making the female experimental and production molds. Since the dilatant elastomeric mold can be readily formed to mold a variety of sizes, the number and cost of female molds required can be kept to a minimum.

VII. BENEFIT COST ANALYSES OF THE IMPACT OF A MOLDED POROUS SHOE UPPER

Each shoe process, whether it be Goodyear welt, stitchdown, cement, injection molded, sandal construction, etc., finds its own niche. The U. S. shoe industry being a marketing and sales oriented industry uses the world as its procurement playground. We are recommending a new manufacturing technology be developed for porous synthetic uppers eliminating the need for the cutting room, the fitting room, the lasting room and the need for pattern making. Soling and heeling would be replaced by evolutionary equipment resulting from the present technology used in the manufacture of unit soles and injection molded bottoms. Finishing of the shoe upper would be done on a finishing rink. The rink could be mechanized, automated or a combination of mechanized and manual operations depending upon the style of the shoe. By employing this capital intensive approach to shoemaking and by reducing dramatically the cost of materials and by the inherent vast improvement in productivity, we would expect that the cost of the molded porous upper and molded bottom would be less than half of the manufacturing cost of conventional footwear of either the cement welt, stitchdown, slip lasted, or other current processes.

With the development of this low-pressure liquid molding technology, we would expect that the U. S. footwear industry could again become an exporter of this type of footwear to developed nations as well as developing nations. At a later time the technology could be licensed to other developed nations and developing nations without the risk of a cost advantage on the part of the developing nations since the labor content of the process is so very low and the capital intensity is so very high. We would expect that the development program required to arrive at a production prototype system for both the molding operation of the shoe uppers and a more cost effective manufacturing operation for the low-pressure molds and for a semi-automated finishing rink is well within the 3 to 5 year limit and the cost and time for the development are being studied at this time.

VIII. BARRIERS TO IMPLEMENTATION OF THE RECOMMENDED TECHNOLOGY-- BULK PROCESSED MATERIAL TO NEAR FINISHED SHOE

In discussion with shoe manufacturers, their principal question to this recommended new process of upper manufacturing was the expected limitation to styling. Their fear was that everyone would have the same process, and hence all shoes manufactured utilizing porous synthetic uppers would be so similar that there would not be a brand identity. We believe that this new process of manufacturing uppers will offer a freedom of styles and a uniqueness that is only limited by the imagination of the stylist and the manufacturer.

Our concern with the development, because of its capital intensity, is that the process will be available only to the manufacturers who have sufficient capital to purchase the equipment and provide the necessary capital for mold development and mold changes as the market dictates.

IX. COOPERATIVE TECHNOLOGY DEVELOPMENT BETWEEN GOVERNMENT AND INDUSTRY

We concur with members of the industry that a research institute in the U.S. supported by both the industry and by the Federal government is highly desirable. The institute could act as a depository and disseminator of a data base for all aspects of the shoe industry including marketing, manufacturing, research and development. Programs could be sponsored solely by supporting members of the industry as universal activities as well as groups of individual members. Longer range development activities and, in particular, applied research activities could be supported jointly by the industry and the Federal government.

In the planning of a shoe industry institute, the benefit/support parameters will have to be explored thoroughly, in particular, in the light of previous activities on the part of the government such as the implementation of the Apparel Research Foundation. This particular foundation flourished in its first three years of existence, but then the support from the industry dried up.

FINAL REPORT

on

CANDIDATE INNOVATIVE MANUFACTURING TECHNOLOGIES FOR THE U.S. NONRUBBER FOOTWEAR INDUSTRY

for

NATIONAL BUREAU OF STANDARDS

May 12, 1978

by

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TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

The major findings of this program are divided into two categories, pecific and general.

pecific

1. Three basic technology/application areas are suggested for ndustry consideration. They are recycling leather wastes, leather finishing y shoe manufacturer, and improved adhesive bonding. Since the first two irectly involve leather, they are heavily biased toward men's shoes. The hird item for bonding could apply across the board wherever synthetics nd leather are used.

2. The men's footwear segment is an ideal candidate for technology and indeed for nontechnical) consideration due to its size and relative ability to withstand import penetration. Demand for leather in men's shoes should emain at the present level, and quite possibly increase, while the available upply will be more avidly sought by U.S. and foreign buyers. Greater leather vailability and more control over materials used would greatly assist the .S. men's shoe manufacturer.

3. The bonding process greatly impacts production for a wide spectrum of footwear products. Any review of a shoe production sequence clearly oints out the number of bonding operations, their labor-intensive character, xtensive space and materials needs, as for lasts, and the steps required to aintain adhesion quality. Significant improvements in the bonding process ould offer benefits across a wide front.

4. For improved adhesion bonding an innovative technique is suggested utilizing magnetic induction bonding. This method, selectively used lsewhere, offers the potential benefit of essentially "instantaneous" bonding nd, perhaps, improved performance. Two other more traditional techniques are lso noted.

5. Specifically, recycling leather wastes considers the potential pplication of cryogenic techniques. Waste may be ground into a form that an be more easily applied to a variety of applications ranging from integraion with polymers to formation of a web form of leather.

6. For leather finishing by shoe manufacturer, new/different techniques are suggested that might facilitate and improve this process. By so doing the shoe manufacturer might have greater materials control either by vertical integration downward or via a change in the material used during the work-in-process sequence.

General

1. At the conclusion of this program more questions than answers persist. Although much has been written about the U.S. shoe industry, it is difficult to obtain a clear, consistent perspective of exactly what is happening and, more importantly, what are the forces driving the associated changes. Part of the difficulty is attributable to the wide variety of products offered by the industry. Part also seems to derive from sincere differences of opinion by nominally equally knowledgeable observers. Typically the reasons for the extent and pervasiveness of import penetration brings forth a wide variety of responses, some conflicting. Many of the opinions offered are difficult to substantiate, one way or the other. Given this situation, the danger of suggesting corrective programs to address perceived problems raises many questions -- with resultant hesitation. To the extent possible this Battelle effort has attempted to address only those problems that are not vulnerable to the problems described above.

2. The recurring theme of style change continues to plague the industry. Where the consumer indulges in capricious demand behavior, the manufacturer attempting to satisfy this demand must be extremely adept at anticipating the changing winds (if possible), quickly reacting to new fads (and attempting to define and capitalize on the market "window"), and ultimately marketing a competitive product that usually calls for some trade-off between price and style.

Basically the demands for style responsiveness do not fall within the manufacturing/production domain. The suggested areas of technology/application do not pivot upon the style dimension: their implementation should be impervious to style variability.

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INTRODUCTION

In late 1977 a dialogue was initiated by Ms. Margery H. King, Manager, NBS Shoe Team, with staff of Battelle's Columbus Laboratories (BCL). The objective was to consider means by which technology might address some of the problems currently being experienced by the U.S. nonrubber footwear industry (subsequently called the U.S. shoe industry). A formal request for proposal (RFP) was issued in mid-January, 1978 and a contract was let soon after in mid-March.

This report comprises BCL's analysis and recommendations.

OBJECTIVES AND SCOPE

Specifically the study would seek to identify technologies that might be applicable with advantage to the U.S. shoe industry. The analysis would provide substantiation based on qualitative and quantitative inputs, with the quantitative input probably more limited in both breadth and depth. As appropriate, a potential role for the U.S. government would be suggested to achieve the desired goals.

The program was bounded in two ways, as follows:

o Only technologies addressing the manufacturing/production segments would be considered, with nontechnical factors included only as they impact on the technical considerations.

o Any technologies suggested should offer a high probability of acceptance and implementation within a 5-year time period.

BACKGROUND

Over the past decade the U.S. shoe industry's competitive position has been seriously eroded within the U.S. domestic marketplace. Although some of the associated problems are unique to the industry, many are simply another variation of recent adverse trends experienced by companion U.S. industries, including consumer electronics, textiles, and steel -- to name only a few.

Particularly where total market demand is fairly stable, as it has been for U.S. consumption of shoes, the loss of market share has inevitably led to reduced sales for U.S. manufacturers with a subsequent train of events including company closings and bankruptcies, mergers, shifting of manufacturing facilities both within the U.S. and offshore, and loss of jobs. The latt may be the most sensitive and unpalatable of the lot, and is certainly the dominant "gut" issue. Such events incur heavy pressure both upon the industry and the U.S. government to seek means of redress to reverse, stop, or slow down the negative effects described above. In some ways the U.S. shoe industry has responded most vigorously on its own, without support from the Federal government. In other ways it is seeking assistance from Federal agencies arguing that other governments bolster their own shoe companies in a manner that places counterpart U.S. companies at a competitive disadvantage. The nature of such support by other governments ranges widely but all instances reflect a government/industry working relationship quite different from the sometime adversary U.S. situation. One desired output of this study is a better understanding of how the U.S. government might be able to better work with industry.

The industry is most complex, characterized by a very heterogeneous product line catering to men, women, and children. In some parts of the marketplace style is critical, as for most women's footwear and the so-called "fast" shoes. In other segments, such as much of the footwear offered in the high-volume, discount stores, price dominates. In some segments of the more stable men's market, both style and price must be considered. The presence of these manifold factors, sometimes conflicting, raises fundamental questions on two levels: first, what is actually happening (implying a strong need to obtain good information) and, second, why is it happening (suggesting that, even if we have "perfect" information, can we understand the basic driving forces leading to the events identified).

Although this program only considers the technical innovations in the manufacturing process, obviously the ultimate concern must be more far-reaching. Experience within other industries often indicates that fundamental and deep-rooted changes affecting a given industry, for better and worse, may embrace decades to bring about basic structural change. Sometimes technology is a major dirving force, as in the semiconductor industry, while for others structural transformations may entail other factors, for instance, as a shift in manufacturing a product to overseas locations to incur labor savings. Technology may, indeed, make a major contribution to address some of the industry's problems; more likely, it is a necessary but insufficient input.

METHODOLOGY

The timing and budgetary constraints on the program dictated that this effort should be highly focused. Therefore it was divided into three segments: obtaining and digesting a large variety of source material inputs generated by others; holding internal BCL creative (brainstorming) sessions to generate candidate ideas; and structuring, evaluating, and distilling the candidate ideas to a limited few worthy of further analysis.

At the outset a great deal of material was obtained from the NBS shoe team drawing upon information they had gathered, and from a wide range of other inputs from government and private industry sources, such as AFIA.

During the program itself subsequent information has been obtained from NBS. Independently we have gathered material from other, although similar, sources and have also visited two industrial sites including a last manufacturer and two locations of a major shoe manufacturer. As an overview we read through a 1966 BCL report prepared for the Department of Commerce's Economic Development Administration, "Opportunities for Increasing Markets and Employment in the Shoe Industry (Nonrubber)".

With this basic background in hand, the two-man BCL core team then solicited inputs from various BCL staff during a number of creative sessions. The persons participating in these sessions offer capabilities in a range of disciplines: familiarity with aspects of the shoe-making process itself, technologies drawn from contiguous industries that might apply to the shoe industry, basic technologies that cannot specifically be coupled with given industries or applications, industrial practices generally, and industrial technology transfer. A purposeful bias in choosing the participants was their strong orientation in materials and related areas. In these fields, it was believed, BCL enjoys especially strong capabilities and could most likely offer its most innovative thinking.

The format for these sessions generally followed a sequence in which the substantive discussion was preceded by a briefing to the group to familiarize them with (a) the general background for the program, including why the U.S. government was interested in the subject, (b) a brief description of the actual manufacture of a shoe, and (c) the mandate for the BCL program. The subsequent discussion was essentially open-ended with no attempt made to squelch ideas regardless how audacious or outlandish they might seem. The intent was to elicit creative thinking while imposing a minimum of boundaries. Questions sought to clarify and perhaps suggest how an idea might be applied, without attempting to judge its feasibility.

It should be pointed out here that the intent of this technique is <u>not</u> to even attempt to obtain every possible good idea nor to spend a great deal of time toward this end. Consistent with the spirit of the program, we endeavored to identify at least a few good ideas -- potential "nuggets" -- that would prove worthy of further analysis. Generally this methodology encounters two types of error as the process continually seeks to obtain smaller subsets om larger populations. One error entails dropping a worthwhile candidate more knowledge were available or subsequent investigation were performed. e other type of error involves pursuing a candidate that ultimately turns t to be fruitless, and therefore time and funds are consumed that might t least with hindsight) have been better expended elsewhere. No means e available to reduce these errors completely. However, as noted above, e objective is to generate a viable subset at the conclusion, and therere disproportionate attention cannot be given to insuring that the subset entually chosen is necessarily the best of all possibilities from a wide pulation.

The two-man core team reviewed all the outputs from the creative ssions and made a first cut to drop those that appeared to offer no atactiveness at all. The criteria for this distillation were several, inuding those basic constraints laid down by NBS at the outset, but initably judgments by the core team weighed heavily in the analysis. A oup of 11 was ultimately selected from the larger population. As this oup was further evaluated and reduced, selected interviews were held with few BCL staff to obtain more detailed information. These discussions ffered greatly from the earlier sessions described since these were highly cused on specific technologies/applications. With such inputs and various ckground material, the 11 were reduced to 3 candidates (to be described). l subsequent analysis was based on these 3 and no further consideration s given to the others that had been discarded.

ANALYSIS

Initial Review

As noted, the raw outputs from the creative sessions were reviewed the two-man core team to generate the subset listed in Table 1. Essentially e criteria described in Table 1 were applied to the larger group but in a ss structured manner. Those candidates that did not survive this first cut e listed in Appendix A. Again, the intent was to very quickly and effiently obtain a smaller group of perhaps 5-15 candidates that we would then view more intensively.

TABLE 1. FIRST CUT OF TECHNOLOGY/APPLICATION CANDIDATES

Number	Technology/Application (A)	Use by Non-Shoe Industries (B)	Breadth of Potential Impact (C)	Magnitude of Potential Impact (D)	Universality of Application (E)	Ease of Adaptation/ Applicability (F)	Speed of Adaptation/ Applicability (G)	Total (H)	Number
1	Recycling leather wastes	M	H	H	M	L-M	M	21	1
2	Leather finishing by shoe manufacturer	M**	H	M	M-H	M-H	M	22	2
3	Pliable leather on last	L	M	M	H	L	M	16	3
4	Leather irradiation on last	L	L	L	L	M	M	10	4
5	Shrink plastic on last	H	L	L	H	M	M	18	5
6	Wood substitutes	H	L	L-M	L	H	H	19	6
7	Improved adhesive bonding	L-M	H	H	H	M	M	23	7
8	Automated defect recognition	H	H	L-M	L	L	L	15	8
9	Lasers for production	L	H	L	L	L	L	10	9
10	Laser formation of lasts	L	H	M	M*	L	L	14	10
11	Parts marking	L	H	M	M	M-H	M	19	11

Legend: H (High): 5; M (Medium): 3; L (Low): 1 [M-H: 4; L-M: 2].

* Applicable to last manufacturer.
** Mainly related to various products in final form.

In Table 1 the 11 candidate areas of technology/application are listed in Column (A), along with the six criteria [Columns (B)-(G)] imposed to reduce these 11 to the ultimate 3. A brief description of each of these columns follows.

Technology/Application [Column (A)].

1. Recycling leather wastes. Within the shoe-manufacturing process leather wastes are comprised of two groups: at the input material discarded due to blemishes, scars, etc., and good material set aside during pattern cutting. Recycling might use this waste, and possibly waste from the tanning process, for several useful purposes.

2. Leather finishing by shoe manufacturer. The manufacturer might buy the leather from the tanner in an unfinished state, probably at the crust stage, and then finish the leather either at the material stage before any work is done on it or at the end of the shoe-making process.

3. Pliable leather on last. A pliable leather might allow for easier fitting and shaping on the last with any cutting of the leather done at this point.

4. Leather irradiation on last. This involves impregnating the leather with monomeric type materials, forming on the last, and then irradiating to form a polymeric reinforcement. Properly done this technique might eliminate finishing the leather at a later stage of manufacture.

5. Shrink plastic on last. With a shrink plastic the material could conform to the last and take its shape. This would possibly lead to a more efficient fitting operation for shoe uppers.

6. Wood substitutes. Where wood is called for, perhaps various synthetics having a natural wood appearance, may be used to facilitate the manufacturing process.

7. Improved adhesive bonding. The desirability of faster and/or better bonding is apparent, especially as more synthetics are used. The possibility of leather-to-leather or leather-to-synthetic bonding may also be achievable.

8. Automated defect recognition. Both for leather and synthetics, automated defect recognition could minimize or replace a major labor-intensive process. Quite possibly the output from this process might be linked to the production cutting to provide a totally automated system.

9. Lasers for production. Although selectively lasers are used for pattern cutting, lasers are not used in production-cutting operations perhaps because basic problems exist in applying lasers to the actual production process.

10. Laser formation of lasts. Possibly lasts can be formed by the intersection of two laser beams, with guidance provided by preprogrammed computer inputs. The focused laser beam would cause a monomeric material to cure in the form of the last.

11. Parts marking. Individual parts and work-in-process can be marked and identified for a real-time information system. This might also facilitate the entire data information system for the employee's piece rate system.

Criteria [Columns (B)-(G)].

(B) Use by non-shoe industries. For any given technology/application, the technology in question may be totally new for any application or it might draw heavily from use in non-shoe industries. Wood substitutes, parts marking, and automated defect recognition are all applied in various forms in other industries for a spectrum of uses. None of the three mentioned, for instance, appear to enjoy any application -- certainly not widespread -- within the U.S. shoe industry. At the other extreme, laser formation of lasts and pliable leather on last -- both unique to the shoe application -- appear to have no counterparts in other industries.

Use in non-shoe industries suggests that where application has been successful elsewhere, a technology-transfer process might be appropriate. Although the transposition may not be 1:1, that is, the non-shoe application may differ significantly from the shoe situation, there is still some experience reservoir from which the shoe manufacturer may gain beneficial insights. Numerous examples can be cited of such transfer and borrowed experience; for instance, regardless of the ultimate result, the shoe industry ained much knowledge from the vast amount of R&D and related expenditures hat Du Pont put into Corfam poromeric materials.

Conversely where a technology is wholly new and untried, such as aser formation of lasts, the questions are many, the risks are high, and the robability of success relatively low. Quite possibly, however, the payoff ight be very substantial should success occur. From the practical standpoint -- all other things being equal -- related experience elsewhere provides a major advantage to the shoe industry.

(C) Breadth of potential impact. A recurring theme in the literture and from the interviews is the concern with the volatility and capriiousness of the style ingredient within the industry, particularly for omen's shoes. It was emphasized frequently that today's hot sellers may ecome tomorrow's relics. Although there appear to be a number of breadnd-butter lines, the industry is driven now by the consumer's wishes and as become style conscious -- again, with the women's sector leading the way. he danger persists that some technologies that would advantageously address urrent needs might obsolesce quickly.

Therefore, one criterion of concern was the breadth of diversity f applicaton and, where possible, its indifference or imperviousness to he style fad. Optimally, a technology that could be used for men's, women's, nd children's shoes is more attractive than one only applicable to, let's ay, children's athletic shoes. In similar fashion, a production process ised by many lines for basic functions also serves as an ideal. For intance, adhesive bonding is a basic process that will become more critical in he future. Improvements here, even selectively, would have broad application vith only nominal danger to obsolescence due to style fashion.

(D) Magnitude of potential impact. This criterion addresses the extent of the beneficial impact attributable to the technology in question. It specifically seeks to avoid undue concern for the potential impact of the technology upon the <u>entire</u> shoe manufacturing process. Most likely <u>any</u> technology suggested would have relatively little impact since the manufacturing sequence comprises many steps, each contributing only a small amount to the totality. The scenario here assumes that the technology will be applied, and then attempts to assess the extent of the benefits that might accrue. Implicitly this line of reasoning requires that the present state of the art and related factors be known to then provide a point of reference. For instance if lasers for production is considered then the traditional means of cutting, as well as the newer water-jet techniques, must be included as part of the baseline for comparison. Any evaluation of this item assumes that the technology can be applied -- for the time being, regardless of the initial cost -- and then questions the depth of its impact.

Perhaps a simplistic means to regard this criterion is to consider a "so what" question. Here we assume that the technology can do "everything" its proponents contend, and we raise the question "so what?". Optimally that impact should be great (again, without considering the cost of reaching that point).

(E) Universality of application. The U.S. shoe industry is populated by a large number of small companies, although the concentration ratio is quite high with dominance by a few major firms. If a given technology/application can only be adapted by a large company, then an inherent bias is introduced to any associated recommendation. Hopefully any candidate technology should be available with equal ease to both small and large manufacturers. This ease of use is a function of several variables, including front-end cost, needed personnel for operation, extent and diversity of the product line, size of manufacturing plant, length of runs, and similarity with already-existing processes that the new technology/application either replaces or modifies. Obviously where front-end costs are high, the smaller firms -- perhaps those under $10 million annual sales volume -- are probably excluded from its use. At the other extreme, the possibility exists that certain techniques for improved adhesive bonding may be relatively easy and inexpensive to apply, thereby providing a technique that all can easily adapt.

The pooling of resources brings a different question into play. For instance, the technology/application of recycling leather waste might be most persuasive when many companies provide their waste to a common point; for a larger company this constraint may not be necessary. The question of pooling is not directly addressed in this criterion. Quite possibly it is appropriate at the conclusion of the analysis when government participation is considered.

(F) Ease of adaptation/applicability. The candidates range widely in their potential applicability to the shoe industry. For some the technology in question is not used anywhere and therefore a major R&D and/or design and development (D&D) activity is required. Under such conditions the eventual benefits are questionable, both to whether they may eventuate at all and, if they do, their nature and extent. For the more "far-out" suggestions, such as laser formation of lasts, a major gap exists between present status and ultimate application to the shoe manufacturing process. This realization in no way belittles the idea but it recognizes that a major bridge has yet to be traversed.

On the other hand, the category on improved adhesive bonding builds upon ongoing processes both within the shoe industry and elsewhere. Admittedly some revolutionary techniques might be introduced with considerable benefits, but the base already exists -- certainly for the more probable evolutionary improvements. As a generalization the greater the extant experience base, the greater our confidence in applying a new technology and, most likely, the easier it will be.

There is ample precedent to suggest that the adaptation process is often very complex and convoluted. Success in a given industry for a specific technology does not necessarily ensure success in a contiguous industry. The shoe industry presents a number of extremely demanding conditions that are either unique or nearly so, such as the requirements to accommodate the 3D configuration of the human foot, the overriding need for comfort, and the volatility brought about by style sensitivity.

(G) Speed of adaptation/applicability. In many ways this criterion is closely related to the previous one. Where a change takes many years, perhaps 5-10, then most likely it must address a generic function that will not obsolesce. As previously noted the desirability of identifying and addressing those factors that appear relatively impervious to change is a major goal. Also, the longer the period of adaptation the greater the confidence the potential user must have that the technology in question will provide the anticipated benefits. Generally, the shorter the adaptation period, the better. Typically change of a revolutionary nature entails longer periods because it requires numerous and significant changes on the part of the user and often an associated infrastructure.

* * * * *

The six criteria just noted were applied to the 11 categories of technology/application. This evaluation was not a finely tuned exercise but one more directed to obtaining usable outputs. The technique deemed best under the circumstances was the application of a High, Medium, and Low categorization for each cell. Therefore each line item of Column (A) was evaluated with respect to the six criteria and a judgment made. In a few places a hybrid judgment seemed best, as Low-Medium. Each of the designations was given a numerical value, and the cells in any given row were totaled, Column (H), to obtain a numerical ranking as shown in Table 1.

The evaluation of the 11 candidates using the criteria noted above allows us to efficiently choose a subset from a larger population. We would be hard pressed to justify small differences, such as the relative attractiveness of a candidate with a total of 18 compared with one of 19; the method simply does not allow for such precision. Conversely it is generally quite good at clustering the various candidates into broad families at either pole. For instance, a candidate receiving a total of 10 is considered much less attractive than one with a 23. Here we believe that the justification to retain the candidate with the higher ranking and drop the lower is soundly based.

Inevitably much qualitative interpretation is called for, requiring inputs that are difficult to categorize for various criteria and also difficult to quantify. If any overriding criteria provided the major driving forces to the final selection, they would be the following:

o The desirability of seeking a technology/application that ll not be easily buffeted by the winds of style change and other short-rm volatilities within the industry

o The need to obtain improvements that may be applicable for wide spectrum of shoe manufacturers without a prohibitively high or fficult threshold of entry

o A high probability of success should the industry enthu-astically and aggressively support the technology

o A reasonable confidence that beneficial application might achieved within a few years -- given adequate support.

With these thoughts in mind, and the review noted in Table 1, ree candidates were chosen for subsequent analysis. They are recycling eather wastes, leather finishing by shoe manufacturers, and improved ad-esive bonding. The subsequent discussion relates only to this group.

Specific Technology/Application Review

ntroduction

Two of the candidates chosen pertain directly to leather utiliza-ion and consumption by the U.S. shoe industry. This subject is especially opropriate to address for two reasons. First, the men's group is the second argest footwear consumption item in the U.S. In 1977 about 172 million airs were sold (domestic production plus imports), second only to the omen's 334 million. The next largest item was "slippers and other" cate-ory at about 67 million. As contrasted to the women's group U.S. consump-ion of men's footwear has grown over the past 12 years by about 20 percent, hile women's has dropped over the same period by about 4 percent. These wo groups combine for 2/3 of the total unit market and a much higher per-entage of the dollar sales volume.

Over the same 12-year period, the penetration of imports into the .S. shoe marketplace has been much more pronounced in the women's sector han the men's. In 1966 import penetration in the men's sector was about 1 percent and by 1977 it had risen to 40 percent; generally this has been a monotonic increase with a break in that pattern in only 2 years. The analogous women's figures are about 18 percent and 58 percent, with a roughly similar pattern of increasing import penetration except for 1 year. For whatever the reasons, the capacity of foreign makers to effectively penetrate the U.S. market is much more potent in the women's than the men's sector. Indeed, this strength is almost 1-1/2 times as great based on pairs sold.

The combination of these two factors implies a focus for our attention, especially if we make the bold assumption that these past trends can be extrapolated. We have no conflicting information to argue otherwise over the next few years, namely that imports will continue to gain an increasing portion of a decreasing product demand ("pie"). The largest and most import-resistant segment of the industry is men's shoes, a major user of leather.

Of the finished leather produced by U.S. tanners about 2/3 is bought by the shoe industry and most of that leather is used for uppers in men's shoes. In all the other sectors the penetration of synthetics is either great or total, as the nonexistence of leather in athletic shoes. Recent trends suggest that the demand for leather will stay about the same or possibly increase. Admittedly some persons argue that leather will continue to give way to synthetics even in men's shoes, but it appears the desirability of leather for much of the men's product line is fairly secure.

From the supply side problems abound. Leather delivery intervals may typically range from 3-4 weeks, with an extreme of 9-11 weeks (as noted by one source). Foreign sources are being sought, Chile, for instance. The U.S. tanners are hurting due to new equipment needed for pollution control, high labor costs, and more intense competition from non-U.S. tanners (sometimes allegedly subsidized by their respective governments). Also the U.S. tanners input obtained from the raw hide producers may be in jeopardy: in 1976, more than half of these hides went overseas.

Leather availability is a concern; so is its price. Finished leather costs range from $1 to $1.50 per square foot thereby contributing greatly to unit costs, typically about 40-50 percent. <u>If</u> the price can be reduced -- assuming availability -- the leverage potential is great.

Given all the factors cited, two of the categories chosen -- ecycling leather wastes and leather finishing by shoe manufacturer -- ddress the general leather area.

The third category, improved adhesive bonding, reflects on a ifferent concern. With the increased acceptance of synthetics, bonding - rather than stitching -- in many variations has become an integral part f the production process. As synthetics become even more pervasive, bonding will be even more critical -- perhaps even for leather. Several spects should be considered.

To varying degrees, bonding takes time. Sometimes the drying eriod is quite short, such as hours, but in other instances it may be long, erhaps as much as a day. For certain types of shoes the bonding together f components occurs several times during the manufacturing sequence. During the drying periods, the work in process, be it on a last or joining of ut patterns, requires time and space. While the drying process takes place, ypically no other work is being performed on the work-in-process item, i.e., o value added occurs. Therefore the production process is protracted, dding to the total unit cost.

Perhaps to a lesser extent but still of importance, the fidelity f the bond sometimes comes into question. The observation is often made that etter quality shoes are made by the West Europeans (catering to the igher priced market) and the poorer quality products emanate from Southeast sia (footwear catering to a less expensive taste). There are many variaions of these themes, some in direct contradiction. Whatever the true ircumstances any technology offering enhanced bonding performance should e welcome. As a paragon it would be highly desirable to introduce improved onding processes that offer both faster drying times and better bonds.

echnical Discussion

Recycling Leather Wastes.

Recycling today is a particularly attractive subject given the keen nterest in conserving resources, especially energy. A number of options for sing leather wastes have been suggested, including the following variations:

reconstitution into a continuous web to produce a leather suitable for men's uppers; reconstitution into a leather-like material that could be used on the inside of uppers, thereby requiring less esthetically; production of a material that can flow directly on the last without pattern cutting; and integration of waste fibers into polymers to make the synthetics more leather-like. The options range from the speculative, such as forming the leather directly on the last, to others that can probably be achieved with relative ease, as integrating leather waste with polymers. These options will be discussed subsequently.

Based upon a number of inputs the men's shoe manufacturer only utilizes about 70 percent of the leather material that he buys from the tanner. Of the remaining 30 percent, 1/3 is discarded due to initial material imperfections, such as blemishes, scars, tic marks, etc., and the other 2/3 results from the waste incurred during the pattern-cutting process wherein 100 percent of even "perfect" material cannot be used. Experienced pattern cutters are among the most highly paid piece workers in the factory, and even the possible advent of automated pattern cutting in the production sequence would not totally eliminate this waste (or even significantly reduc it). Given the irregular shapes of component patterns, there is simply no way to use 100 percent of the material. One knowledgeable source stated that men's shoes are most flagrant in this respect due to the nesting constraints of their larger sizes (relative to women's and children's).

The technology to be suggested here considers how this waste may be used not only for the sake of recycling but, perhaps more importantly, to help ease what appears to be a tightening supply situation for U.S. manufacturers seeking leather material.

Some recycling of leather wastes is now being carried out by processing the materials using pulping and paper-making-type techniques. Leather wastes are ground into semifibrous or particulate forms dispersed in wastes. These methods are generally not very efficient with respect to time and energy considerations. However they may still offer some advantages for the basic recycling concepts depending upon specific end usages and desired characteristics.

Another technique for producing fibrous materials from the leather stes utilizes cryogenic processing. One variation uses semicommercial uipment available from at least two companies. The basic technique, re-rred to here as cryogenic hammermilling, involves cooling dampened ather wastes to cryogenic temperatures and then striking the cold materials th high-speed "hammers". This action causes the brittle materials to atter and break apart. As the materials are struck repeatedly by the ham-rs, fibrous forms of the wastes are produced; these fibers are channeled t of the system once they have achieved certain fiber geometries.

If smaller fibers or particles, including leather "powders", are sired, recent experimental techniques developed at BCL can produce them rough further cryogenic processing operations, utilizing regular grinding dispersion methods. These experimental techniques have also been used produce powders from various virgin polymeric materials, as well as from her waste materials such as rubber. These other types of powder materials ght be appropriate in further developing the "use" options for the fibrous powder leather products (as discussed later in this section of the report).

The potential advantages for using cryogenic processing rather an more traditional techniques are twofold. It is estimated that the cry-enic method will produce the desired fibrous material from the wastes in ss time and with less total energy input. Secondly, cryogenic processing ll produce fibrous or powder leather materials not readily attainable by her processing techniques.

Once the leather wastes have been processed into a reasonable form, veral "use" options can be considered for the materials in the shoe. Sev-al of these options are listed and discussed subsequently but the listing by no means all-inclusive. The options suggested are based on fairly fun-mental technologies and the materials produced might be usable in shoe pers or in less demanding and less visible areas such as inner liner or le materials, depending upon the characteristics obtainable from the re-cled materials. In addition, whether the materials formed from the recy-ed wastes would be usable in high fashion, stylish women's shoes, or be mited to men's, children's, or athletic shoes will also depend on the characteristics that can be built into the recycled materials and systems. The possibility of marketing new product lines of more utilization-type shoes should also be considered, if necessary, as a means of reusing the valuable leather base materials.

Several of the basic technologies or use options follow:

o Dispersion of leather fibers in water or a similar carrier can be followed by deposition on to screen-type forms to produce desired shapes. If a screen last were to be used, for example, a shoe upper could be formed using vacuum techniques to aid in depositing the fibers. Latexes, sizing materials, powdered resins, and other systems might also be mixed into the fibrous slurry and deposited on the screens at the same time for reinforcement and strengthening of the final shape.

o The basic concept of forming the fibrous wastes on to screens can also be carried into a paper-making type of operation to produce a continuous web from the leather wastes. Such a web can then be reprocessed similar to virgin leather to produce shoe uppers, inner liners, shoe trim items, etc. The continuous web of fibrous leather might also be used as a base for producing the polymeric synthetic leather materials now used in high-fashion shoes. The fibrous leather could offer advantages of better moisture absorptivity, breatheability, and comfort than the textile base materials now used.

o It is also possible to deposit the dry leather fibers electrostatically on to forms such as lasts, to produce shoe uppers or formed liner materials. The dry leather fiber form would, of course, have to be reinforced with polymers, resins, or other materials to hold the fibers intact. The resins and polymers might be applied (1) electrostatically as powders, either during or after deposition of the leather fibers, (2) spray or dip-type of coating systems, or (3) ultraviolet or electron radiation-curable materials.

o The fibrous or powder leather wastes could be incorporated into polymeric coatings used in finishing operations to make the coatings more "breatheable". These systems might also be used to finish the screen-formed shoe uppers, discussed above. The type of material or systems roduced might also make a "plastic leather", similar to plastic wood. nis plastic leather could be used to repair blemishes, holes, and other efects in virgin leather materials, particularly if these repaired areas ere to be coated, finished, or otherwise concealed from view. It is oubtful that the repaired area could ever completely emulate a grain eather surface.

o It may also be possible to "spin" the leather fibers into a nread-like form which could then be used to make a leather "cloth". This loth material could then be reused as for woven shoe uppers, woven inner iners, or in similar applications.

Other options than those listed may be more attractive and one f the initial tasks in exploring this recycling concept should be directed oward (1) characterizing the waste "streams" available and the reusable orms of wastes that can be obtained, and (2) identifying the new product nd use possibilities for the recycled leather wastes. These new product nd use opportunity investigations should also not be limited only to the noe industry but could include any industry that might be a candidate to se the recycled materials.

Further research efforts would then be directed toward exploring ne alternatives and options available. While the concept of cryogenically rocessing leather wastes has been tested experimentally, further investigaion of the alternatives and potential product forms, as well as defining ne overall costs and economic benefits of the process, are needed. Most f the R&D efforts would be directed toward exploring the use options of the roducts obtained from the cryogenic processing.

It should be obvious from these discussions that most of the opions described are only in the concept stage and will require a considerole amount of R&D expenditure to investigate their feasibility and to ventually bring the more promising candidates to commercial fruition. The verall concept therefore is relatively risky but it also appears to offer onsiderable economic benefits to the shoe industry. The concept also tresses the recycling of valuable virgin leather feedstock wastes which are ecoming more costly due to competition from foreign buyers of either raw ides or crust leather (as previously described).

It is difficult to estimate the total costs of the R&D program that would be necessary to define the variables in the concept and to bring the concept and use options to a point of ready adaptation by the shoe industry. Surely these costs will run into the several hundreds of thousands of dollars depending upon the breadth and depth of the research efforts.

Similarly it is also difficult to estimate what equipment will eventually be necessary for adaptation of the concepts by the shoe industry, as well as what costs will be incurred for this equipment. Once the research efforts begin to narrow and select the more promising approaches for the basic concepts, equipment requirements will be better defined and cost estimates can then be made. Clearly, this concept and its adaptation are revolutionary in nature, rather than evolutionary and, consequently, the shoe industry will undoubtedly be required to consider new methods and materials, and to invest capital in new equipment. These capital investments could be considerable since essentially none of the equipment presently projected as necessary is available today in the shoe industry.

In addition to the high costs estimated for concept development and capital investment for equipment, potential technical impediments primarily relate to the actual ability to economically accomplish many of the alternatives and options described in these discussions. While the concept of cryogenically processing leather wastes has been experimentally tested, most of the use options have not yet been explored. Therefore the risk of actually being able to accomplish the desired results and products is high.

If concept feasibility and adaptation can be shown, only the larger shoe manufacturers may be able to capitalize the equipment necessary to utilize the concept and use options. This does not imply that the smaller shoe manufacturer would not realize some economic benefits since he could probably sell his leather wastes to the larger companies. In this way he could recover some of his materials costs which he may not economically do today.

Leather Finishing by Shoe Manufacturer.

Any finishing operations considered are limited to only leather ubstrates, since it is impractical for the shoe manufacturer to finish ynthetics on his own. Two variations for leather are addressed here. irst, there is the possibility that the shoe manufacturer may purchase eather from the tanner, probably at the "crust" or similar unfinished tage, and perform the finishing himself using techniques to be suggested ere. Essentially this would simply be a transposition of the finishing rocess, with the possibility that the shoe manufacturer could apply newer nd better techniques to both raise the efficiency of the process and prouce a higher quality material. It also represents a downward vertical ntegration by the shoe manufacturer as he reaches into an area tradiionally controlled by one of his suppliers. In this sense such a change ould address some of the problems discussed previously concerning leather upplies. Difficulties would still persist if U.S. tanners cannot obtain heir needed inputs from U.S. hide suppliers if the latter are shipping uch of their raw hides overseas.

Possibly this change might also ease some of the problems curently being experienced by U.S. tanners. Various sources suggest that .S. tanners will continue to diminish in number for reasons already oted. Perhaps large shoe manufacturers or pooled facilities drawing rom several smaller companies might be better able to withstand some of ne pressures that have forced many U.S. tanners to close.

The second variation considers the advisability of the shoe manfacturer to still buy unfinished leather from the tanner but now the inishing would be performed after the shoe is made, rather than at the nput to the manufacturing process. The advantages to be gained include ne use of unfinished material throughout the process suggesting that any aste incurred -- as discussed above -- would be less expensive, even if not ecycled, since the manufacturer now works with a lower cost material. Also f the finishing is performed on the shoe the manufacturer may be less conerned with scuffing, scratches, etc., during the work-in-process stages, since these often troublesome drawbacks can be compensated for with the final leather finishing. Perhaps a higher quality product may also be obtained.

The primary advantages of finishing the crust leather as an initial operation in the shoe manufacturing plant are the benefits to be gained from working with lower cost starting materials, eliminating damages to the leather finishes caused by shipping the finished leather from the tannery, and tailoring the shoe finishes to particular styles and colors of shoes. The magnitude of these potential advantages is extremely difficult to ascertain due to the inability to obtain meaningful data on the relative breakdown of finishing costs and other factors in the overall picture. If it is assumed, however, that the finishing operations are relatively "high-cost" (as our skimpy evidence implies), they may contribute up to 15 or 20 percent of the finished leather costs. These percentages would probably then translate to 20 or 25 cents per square foot (on average) and could offer an attractive potential when combined with the other advantages.

With the second option (shoe manufacturer uses crust or unfinished leather throughout), the shoes once manufactured would be finished as a final operation. Shoe manufacturers now do some finishing operations by repairing damages to the leather finishes that occurred during shipment of the leather or during the shoe manufacturing operations. Adaptation of this concept would therefore primarily be an extension of present operations rather than starting up a completely new one.

This option, in addition to offering the advantages of the first one cited, also offers the potential for materials savings since trim losses and wastes from the cutting operations would not include the coating and finishing materials. By minimizing these losses it may be possible to consider usage of higher cost, high technology materials, such as polymeric systems that contain no solvents or liquid carriers and cure by radiation exposure to ultraviolet (for thin clear coatings) or electron beam (for thick or pigmented coatings). These materials could also possibly be considered for the first option although their attractiveness would be enhanced if they could offer improved finishes to offset the trim losses. In either f the finishing options, of course, conventional solvent- and water-ilutable finishing systems can also be considered.

For either option the first efforts in considering adaptation f the concept should be directed toward determining the order-of-agnitude economic gains that can be achieved. Once these are determined, nd if they are attractive, the research efforts required can be very nimal if the present finishing systems are to be used. Primary efforts uld be directed toward transferring the technology of finishing leather om the tanneries to the shoe manufacturers.

If the high technology radiation-curable finishing systems are be considered, research efforts to develop prototypes or optimize urrently available materials would be necessary. Depending upon the aracteristic desired in the final finishes, these efforts could be fairly traightforward to be carried out by the finish system suppliers or poten-al suppliers -- if there is sufficient interest by the shoe industry.

Equipment necessary for finishing the leather in the shoe man-facturing plant will vary depending upon the type of finishing materials lected. Obviously the finishes must be applied to either the side ather or the formed shoe by some technique, such as spraying as is now done. riability in required equipment will be more evident in the operations cessary to dry or cure the finishes. Hot-air or similar dryers would be quired for conventional finishes and would be less expensive (under 0,000) in terms of capital investment than the equipment required for the ectron-beam radiation curing which could range up to $250,000. UV equip-nt cost lies somewhere in between. This larger investment would not be tractive to the small shoe manufacturer but he would have the option of ing the more conventional finishes with a lower capital investment.

Many of the technical considerations involved in adapting this ncept to the shoe industry are minimal since much of the technology in-lved is already in use today. Potential impediments relate more to rategic factors, as whether the tanning industry would welcome being vorced from the finishing of leather for shoes. Potential economic ad-ntages that would be gained through the purchase of crust rather than finished leather also need resolution. Since the tanning industry would still need some leather-finishing operations for non-shoe usages, resistance by the tanning industry may be encountered in attempting to carry out the finishing at the shoe manufacturing plant.

Another consideration involves the economics of scale usually encountered in mass production processing. Whether economic attractiveness is reduced by each shoe manufacturing plant doing the finishing rather than the operation being carried out at a central location, like a tannery, is questionable. As one alternative finishing the leather could be carried out at a central location, such as the home office of a shoe manufacturer, and then the finished leather could be shipped to satellite manufacturing plants. This option, of course, potentially benefits the larger shoe companies rather than the smaller ones. Similarly if smaller manufacturers could somehow pool their crust leather inputs -- if they choose to go this route -- that option might offer an attractive alternativ

Improved Adhesive Bonding.

The technologies in this category can reduce the setting time for adhesive bonding. Two of the technologies described have found large-scale use elsewhere in non-shoe industries, while the third is relatively new and would clearly represent a major innovation.

Data consistently indicate that the fitting operation consumes most of the labor cost, about 40-50 percent of the total. The fitting sequence also requires the most time, ranging from 4 hours to several days for a given shoe. Significant reductions in the fitting operation cycle would lower unit cost and, more indirectly, speed up the manufacturing operation thereby offering a number of other advantages more difficult to quantify.

For the technologies suggested, experience ranges widely on their applicability to synthetics. However, little has been done on adhesive bonding of leather-to-leather or leather-to-synthetic. This application represents a more speculative task yet might yield even more benefits if substitute means could be found to join the leather rather than the raditional stitching. From the outset it is recognized that such stitching s the accepted technique since it not only joins the leather but also con- eys the image of quality. Any progress in this field would tie in nicely ith the two other candidates already suggested.

The technologies to improve the bonding or cementing together f shoe parts can be divided into two main categories. The first involves he use of a patented magnetic induction heating process and offers not nly the potential of speeding up the bonding of various shoe parts but lso of developing "super" bonds not obtainable with currently used materials. ne second technology relates primarily to the use of microwave or dielectric eating techniques to accelerate the drying of present or modified adhesive ystems. Each technology area is now discussed in more detail.

With magnetic induction bonding, patented under the name ellerbond [R], a process of "heat sealing from the inside out" occurs. Heat s developed in the desired joint area by a high frequency magnetic field roduced by commercially-available induction-generating equipment. The mag- etic field energizes submicron iron oxide pigment particles that are dis- ersed in a special bonding agent tailored to the materials being joined. hen the particles are energized they produce the heat needed to effect the nternal heat seal. The special bonding agent can be a water- or solvent- ilutable liquid system, a tape or gasket form, or incorporated into one of ne parts to be joined. In addition to joining the parts, the process could lso be used to aid in drying the water- or solvent-dilutable adhesives.

Applying this basic technology to the manufacture of shoes could e directed in several paths. The special bonding agent, designed for eather-to-leather, leather-to-synthetic, or synthetic-to-synthetic mate- ials could be applied to the joint areas of the shoes at some stage prior o the actual bonding operation or at the initiation of the bonding step. ne shoe would be assembled and then exposed to the magnetic field by means f specially designed coil fixtures. Pressure could be applied either dur- ng the activation step or immediately afterward to bring the pieces to be oined into intimate contact. The bonding operation is very brief as com- ared to present adhesive air-drying and reactivation methods, requiring only a fraction of a second in the magnetic field. It, therefore, has the potential for greatly increasing production rates, shortening the turn-around time involved in the shoe manufacturing operation, and minimizing the investment in lasts for specific styles.

This process may also be used to develop high strength bonds, not obtainable with present materials, for cementing high-stress areas, including the replacement of sewing or stitching. Since heat is generated internally in the bonding agent (500° or 600°F, if desired), the use of reactive adhesive materials can be considered. If an adhesive system, based on polyurethanes for example, is formulated using "blocked" polymers, the system will have good stability for application but will react at the elevated temperatures to form thermoset-type bond material. These types of materials are characteristically strong, as compared to bond strengths obtained with conventional solvent dilutable, rubber-based adhesives.

R&D efforts needed to implement this technology into the shoe-manufacturing process primarily call for the development of the specialized bonding agents that would be tailored to bonding the various natural and synthetic materials used in shoes. Included in the development efforts could be an audit of the shoe manufacturing sequence and a selection of the areas of operation and shoe styles that might best benefit from the adaptation of this technology. Additional development work will also be necessary in designing the coils used to apply the magnetic fields, once the basic shoe manufacturing operations and the adaptation engineering have been worked out. Cost for this development work would probably total about $100,000.

Equipment used in this technology to develop the high-frequency magnetic fields is the conventional commercially available induction generators. Therefore it is not anticipated that development efforts will be necessary in the equipment area other than the specialized coil designs noted above. Capital investment for the inductor generators is about $50,000 and the generators would be capable of operating at least two production lines or activation stations.

Potential technical impediments to implement the technology into the shoe industry include the following:

(1) Since the special bonding agents are normally brown in color, it will probably be desirable for the bonding joints to be hidden from view.

(2) The necessity of designing specialized coils for generating the magnetic fields may limit the ways in which the bonding can be achieved since effective application of the magnetic fields has certain space limitations.

With the microwave or dielectric drying technique, the specialized ating equipment is used to speed up the drying of the adhesives for cementg shoe parts together. This accelerated drying, as with the induction ating, offers the potential of quicker turnaround time for bonding parts gether, with many resulting benefits such as a reduced investment in lasts r each style of shoe. This basic technology is now used in other indusies for selective heating since quite often the adhesives can be designed that they are very receptive to the high frequency radiation while the terials being joined are relatively inactive. This phenomenon causes heat be generated only in the bonding areas and prevents the joined materials om drying out, as might occur with the gas-fired heating process typically w used in the shoe industry. In addition, the equipment needed for the crowave or dielectric processes is generally more space efficient than e present drying ovens.

Since the natural rubber adhesives or the solvents used therein e generally not very receptive to the microwave or dielectric frequencies, D efforts would be required to modify present adhesives or to develop new rsions to be used with these drying processes. It may also be possible to rely select from available adhesives to obtain variations that will selecvely heat with these processes. It is anticipated that research efforts uld range from $50,000-$200,000 to develop a family of adhesives suitable r use with the microwave or dielectric processes in the shoe manufacturing dustry.

Equipment costs can be highly variable depending upon the size of e shoe manufacturing operations. Small shoe manufacturers could purchase latively small processing chambers while larger manufacturers would probably need bigger chambers or a multiplicity of smaller units. Microwave or dielectric processing equipment for drying the adhesives would probably cost about $25,000 for the smaller units while costs for the larger units may jump to $100,000 or more. One advantage of this type of processing is that it can be fairly well tailored to the size of the manufacturing operation thereby minimizing capital investments for the process improvements.

Potential technical impediments may arise primarily in the need for the shoe lasts and other materials going into the microwave or dielectric heating process to contain no items that will heat preferentiall The polyolefin polymers or wood used in present shoe lasts would be relatively inactive in the energy fields and would not be affected directly. However items such as the metal pins and various other parts used in present shoe lasts will be most receptive to the high-frequency energy and will cause the polyolefin material around the pins to melt, thereby destroying the lasts. Modern-day polymeric pins and parts could probably be used to replace the metal parts of the lasts but somewhat higher costs for the lasts may result. These increased costs should be minimal, however, relative to the overall potential savings in time, labor, and capital investments for the lasts.

TENTATIVE FEDERAL GOVERNMENT ROLE

As previously noted, a role for Federal government participation is fraught with several difficulties:

(1) As a baseline reference, we assume that the Federal government will only assist the U.S. shoe industry -- or any other domestic industry for that matter -- if the industry cannot harness the resources or the means to help itself. As a separate matter, the question can also be raised whether the industry can fund its own programs, but chooses not to (for whatever the reasons). Our inputs, both personal and otherwise, consistently indicate that the industry does not speak with one voice. It is difficult to discern a majority opinion, a "party line".

(2) The question of Federal support for private industry touches on some very basic, and even sensitive, issues. Some of the suggestions for Federal support would, if implemented, depart from long-held traditions. Whether the government should or even can move in these new directions is clearly beyond the scope of this program. Suffice to say that the appropriate Federal role in supporting a consumer-based U.S. industry is a point for major policy consideration.

(3) Most critical we believe that the question of what the Federal government can do well to support a truly consumer industry, such as shoes, must be confronted. In some way the more traditional marketplace mechanisms might be replaced or modified. Any rational program involving government participation must be premised on the assumption that there is a clear perception of the problems that should be addressed and a means to help remedy them. Both tasks are most demanding, and cannot be taken lightly. Any government-sponsored program implies that both factors are in hand.

With these background comments set down we suggest the following initiatives for NBS/Department of Commerce consideration:

Selected R&D Program Support

From a purely technical standpoint, two major technical programs seem worthy of Federal support based on the associated risks, the benefits that might accrue to a wide range of shoe manufacturers, the projected size of one of the R&D programs, and the nature of the work involved.

Recycling of leather wastes, along the lines described, moves into some areas that have not been previously investigated. The use of cryogenic techniques seems to offer some attractive possibilities but it is still wholly unproved -- particularly with respect to its economic dimensions. Others have attempted to produce reconstituted leather with limited success. It is anticipated that the dual challenge of first proving technical feasibility and then translating technical progress into a cost-effective mode must be confronted. Most appropriately this work would be funded by the government and performed by companies knowledgeable in the related basic technologies.

As a somewhat less ambitious task, bonding of leather-to-leather or leather-to-synthetic will call for major advances beyond today's present capabilities. The experience base with synthetics using a number of the technologies described is quite extensive. For magnetic induction bonding, much has yet to be learned. It is felt that this work would be more straightforward, with higher probability of success than the first program noted above -- but it is not a sure bet. Developmental experimentation is called for rather than breakthrough advances. Most likely, this work can probably best be performed by an organization within the supplier group.

By implication we feel the third technology, leather finishing by shoe manufacturer using conventional materials, can be pursued by industry on its own. If new high-technology materials and processes are considered, government support in this area may then be justified due to the anticipated high costs and associated high risks.

Information Dissemination

Even within the limited scope of this program it is apparent that a great deal of interest has been created in the Department of Commerce's initiative for the U.S. shoe industry. As implied elsewhere this interest comes in many shapes but clearly attention has been focused upon the overall program, and probably many persons perceive the initiative as a constructive activity and a reaching out where none existed before. Therefore it is suggested that the wide dissemination of this report and its companions would help further this cause.

A broad airing of the program's results would allow interested parties to review the findings -- and then critique, modify, and add to them as they saw fit. Typically at the conclusion of a short program, such as this one, we are not overly confident in the rightness of our arguments. The vagaries of the shoe industry only add to our feeling that perhaps there is much more out there that we should know about. Allowing many other persons with different backgrounds to become involved in this process can only serve a useful purpose.

Secondly, and on a much broader plane, the U.S. shoe industry is only one of several U.S. industries that the Department may seek to assist, perhaps in the cooperative technology mode. If similar studies were to be performed in, let's say the steel industry, some overlap would probably occur on an interindustry basis. As a first assumption, others in the non-shoe industries probably share the same interest -- hopes and skepticism --

oncerning the government's role in consumer-type industries where traditionally the government has not been very active.

urther Shoe-Related Studies

The findings from our program do not result from lengthy analyses ased upon gathering extensive data, considering tradeoffs, and ultimately enerating well-reasoned conclusions and recommendations. Consistent with he mandate set at the outset, we strove to identify a few key technologies hat might address pertinent programs. The technical results obtained are ore solid than their economic counterparts. Many questions are basically nanswered:

o How large a research program is required to accomplish at east some of the goals suggested in the leather waste recycling category?

o Would such a program come up with results that make economic ense?

o Can and will the shoe manufacturer move toward doing his own eather finishing?

o Can an effective means of bonding leather to leather or eather to synthetic be found? Can a "super" bond to replace stitching e developed?

o Can the bonding process be accelerated in a cost-effective anner?

It would probably be possible to gain much better answers to some f these questions with a focused program on any of the technology/application reas suggested here. To varying degrees we have the impression that at least ome shoe manufacturers and their suppliers would be most cooperative in contributing ideas, information, opinions, etc., toward these ends.

APPENDIX A

DISCARDED OUTPUTS FROM CREATIVE SESSIONS

APPENDIX A

DISCARDED OUTPUTS FROM CREATIVE SESSIONS

The following technology/application areas were suggested during the creative sessions but were not considered appropriate for subsequent analysis (others that clearly did not relate in any manner to the program are not even listed here):

- Treatment of leather to facilitate cementing
- Automated leather repair
- Charged fluid droplet technique for pattern cutting
- Customized shoe manufacturing using no last (as with some ski boots)
- Use of nonwovens for uppers
- Heel production using injection molding
- Standards for shoes for quality control and better consumer acceptance
- Thermoplastic rubber for uppers
- Water jet cutting
- Incorporation of materials which are reactive to nuclear exposure and will generate heat internally in the leather
- Finishing of leather with shrink films
- Injection molding or rotoforming techniques to product shoe uppers.

A Preliminary Report:

THE CUSTOM-FIT CONCEPT--INNOVATION IN THE U.S. NON-RUBBER FOOTWEAR INDUSTRY

Prepared for the NBS Shoe Team

by James P. Kottenstette
Denver Research Institute

May 15, 1978

A SUMMARY OF THE CUSTOM-FIT CONCEPT

This report promotes the broad outlines of an idea that could change the U.S. Footwear Industry. The idea is an outgrowth of an attempt to couple potential technological developments in footwear manufacturing with innovation in the footwear industry. The idea is actually a strategy for innovation that links new materials technology and manufacturing methods with changes in shoe retailing.

We call the idea the Custom-Fit Concept for shoe manufacturing and retailing. The concept involves the notion of custom-fitting shoes at the retail level from a limited inventory of size-width tariffs carried by the retailer. In essence, the retailer would offer customers the opportunity to select a shoe style with the promise that he or she would be custom-fitted. This notion is clearly a departure from the retailers' current reliance on a multi-tariff shoe stock to produce satisfactory consumer shoe fittings.

The notion of custom-fitting has been borrowed from the ski boot industry. Ski boots are ordinarily manufactured in a limited number of sizes and widths and they are made to conform to the skier's foot by adjustments in the boot's lining and insole, including adding or removing insert material. The intent to maximize the number of feet that can be successfully fit using a single size-width tariff is implicit in the strategy of manufacturing and retailing ski boots.

Custom-fitting is thought to increase the manufacturers "length of style run" (volume of production of a particular item without changing size or style). It is the promise of increased "length of style runs" that suggests cost-savings and greater productivity for U.S. footwear manufacturers if this concept can be adopted.

The technological components of such an innovation include the development of suitable insert materials to effect the custom-fitting objective, the development of manufacturing methods to facilitate incorporation of insert (fitting) materials, and, the development of practical fitting techniques for use by the retailer. From an innovation perspective, however, the strategy also calls for an industry-government effort to improve basic information about shoe fit, to preserve the results of the material development effort for the benefit of the U.S. footwear industry, and to assist in the training of personnel engaged in manufacture, retailing and supply of shoes and shoe components.

INTRODUCTION

The thrust of the Custom-Fit Concept presented here is to establish a basis for the retailing of shoes in multi-width tariffs based on single tariff shoe production schedules. Under this concept, the final fitting of a shoe would take place at the retail point-of-sale, using techniques adapted from the manufacture and retailing of ski boots.

The potential of this concept may be seen in Figure I where the relative number of men's shoes sold by retail outlets is tabulated by size and width.* If, for example, the "D" width tariff could also be fitted to persons with a "C" width--without a change in shoe size (length)--then the production of shoes manufactured in a "D" width tariff could be increased by approximately 1.5 times. Less dramatic but equally important, an "A" width tariff that also fits "AA" foot sizes represents a 1.25 times increase in "A" width production. It should be noted that while the footwear industry produces each shoe to fit a <u>range of foot sizes</u> (recall the familiar "ellipse" of fits for any particular size-width combination), the table indicates that significant differences in fit are associated with as little as one-fourth of an inch change in foot girth even when the <u>range of foot sizes</u> is taken into account.

The argument being developed here is that increasing production in a particular size tariff between 1.25 and 1.5 times could redefine the "length of a style run" for the individual shoe manufacturer. Lengthening the style run suggests economies in pattern grading, machine-setup time, last making, inventory, inventory control, etc., all areas of cost-savings for a constant production volume. While these savings can be significant, the Custom-Fit Concept also focuses on marketing American-made footwear. While the concept offers consumers custom-fit footwear derived from largely conventional production technology, the mature concept attempts to answer the question "Why buy domestic footwear?"

It is our belief that to revitalize the domestic industry, <u>manufacturing cost-savings</u> and <u>increased consumer preference for U.S. produced shoes</u> must <u>both</u> be attended to--hence the emphasis given here to an innovation in footwear rather than manufacturing technology per se. In fact, the technologies required to implement a mature Custom-Fit Concept are materials-related, manufacturing-related and retailing-related (i.e., to routinely provide for custom-fit); the technologies are broadly defined by the nature of the footwear innovation sought. On the other hand, defining a strategy for implementing the innovation is not nearly

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*This table was taken from <u>Application of the Proportional Grade to Footwear Manufacturing: Workshop Manual</u>, prepared by the American Footwear Industries Association, Arlington, VA (p. 72).

SHOE DISTRIBUTION

The following sales data from shoe stores in the U.S.A. demonstrates a similar distribution.

WIDTHS / MEN'S SIZES	AAAA	AAA	AA	A	B	C	D	E	EE	EE
5							9			
5½							16			
6						13	37		4	4
6½						32	81	9	9	9
7					13	59	155	25	17	18
7½				4	28	103	282	41	29	28
8				9	64	201	515	58	46	38
8½			3	14	100	381	706	71	49	43
9		2	5	23	140	431	706	79	44	42
9½		3	8	32	166	402	657	80	35	34
10		3	12	42	174	333	582	74	26	26
10½		4	14	53	153	264	432	60	18	19
11		4	14	49	110	174	328	41	10	14
11½		3	11	32	60	95	155	21	6	8
12		2	6	16	31	44	77	12	3	6
12½		2	2	6	15	13	31	7	2	4
13				1	3	5	12	4	1	3
13½					2		4	2		2
14					1		2	1		1

FIGURE I

so clear-cut because there are alternative pathways. Selection of one pathway depends on involvement and commitment by the several interests or segments of the footwear industry. These segments include shoe manufacturers, equipment manufacturers, suppliers and retailers. It is obvious that a shared vision of the innovation strategy will be difficult to establish given the different interests. One vision is presented in this report in the hope that it might serve as a point-of-departure for the selection and development of an innovation strategy.

The Technology

In 1964, a small ski boot manufacturer introduced a new boot that began a revolution in the business. The Lange Company (Broomfield, Colorado) produced a single-piece, molded boot in only four size-width combinations. Each boot was custom-fit by the retailer by filling a bladder-like liner with polyurethane foam. The ski enthusiast had the benefit of a well-fitting, well-insulated boot that set the standard for many years. Although other innovations have followed, such as the flow liner and memory foam, each development involves custom-fitting by the retailer.

The experience of the ski boot industry prompted the question: "What might the advantages be if shoe-retailers could actually promise custom-fitting of shoes on a routine basis?" Several advantages were apparent in addition to the potential increase in the length of style runs. For the consumer, custom-fitting might increase the desirability of U.S. footwear.* For the retailer, custom-fitting could provide an additional basis for competition by increasing the number of styles available for consumer selection (fewer size-width tariffs promotes a larger style inventory) and increasing consumer loyalty based on satisfaction with the fit obtained. For an import-damaged industry, the advantage might be that the materials and techniques needed for delivery of custom-fitted footwear could be restricted to use by U.S. firms through patent and license agreements. Finally, from a Department of Commerce perspective, participation in the development of new materials and techniques avoids the threat of distorting the existing domestic industry structure because the "technologies" are not capital intensive nor do they particularly favor one shoe manufacturer or equipment manufacturer over another.

These advantages can be seen by considering how custom-fitting might be routinely achieved. Imagine that for a man's closed shoe style, provision has been made for the injection of an insert material between the lasted upper and its liner. The material to be inserted (and yet

*Custom-fitting may or may not be perceived by consumers as being of value. This will presumably depend on the relative levels of foot comfort with and without custom-fitting and on whether the custom-fitting process is viewed as an inconvenience.

to be developed) must have proven wear characteristics including flexibility, porosity and stability. Stability, for example, might be obtained by triggering polymerization of a matrix-like component in the insert after the fit is assured.

The fit itself might be gauged by the retail clerk through the use of "fitting socks." These socks would be available to the retailer in graded sizes and weights, and would be designed to simulate various amounts of insert material. For example, to simulate the fit of a perfect "C" in a "D" tariff, the upper portion of the fitting sock would need to be approximately 1 millimeter thick. (The sole area of the fitting sock would be made of light weight material, and the sole's thickness would be ignored when compared to that of the upper portion of the fitting sock.) The grade and weight of the fitting sock found comfortable to the customer would also be used to gauge the amount of insert material needed to provide the same feeling of fit simulated with the fitting sock.

A slightly different scenario can be drawn for custom-fitting a lady's open, high heeled shoe. Assume that the shoe upper has been made with a "flow liner" as an integral part. This material (a silicone-based composite for ski boots) redistributes itself to conform to the shape of the foot. The fitting socks used in this situation would be made so that the gauged thickness appears in the sole of the fitting sock rather than in the upper portion (as indicated in the closed-shoe example). This fitting sock is designed to simulate increased insole thickness in the platform area of the shoe. After fit is assured by conformance of the flow liner in the forepart of the shoe, insert material would be added to the shoes' insole in the platform area, to establish the same lift as was provided by the fitting sock. The liner and insert material would then be stablized perhaps by exposure to microwave radiation.

1. Development of the technology. The technology effort needed for this concept is basically one of materials development. The effort should be organized to produce flexible, porous and stable inserts that facilitate their use by retailers. This development effort should proceed hand-in-hand with the development of techniques to aid the retailer in the delivery of custom-fitting. These techniques include packaging and handling of materials as well as simulating the fit as suggested by the use of the "fitting sock."

The development of manufacturing techniques to provide for the introduction of insert material is, of course, strongly related to materials development program. The objective, in this case however, is to minimize the impact on shoe manufacturing methods rather than to introduce change. In the best of all worlds, at least initially, the impact should be limited to the assembly of the shoe liner and/or the insole, and the use of new liner materials.

2. Barriers to implementation of the concept. The barriers considered here are primarily those associated with designing and articulating an overall commercialization strategy that can be endorsed by the footwear industry and supported, in part, by commitment of public resources.

It is presupposed here that a family of insert materials can be developed and proven through consumer trials. It is also assumed that the techniques for incorporating the insert materials can be refined to the point where increased costs of manufacture can be offset by the economies of longer runs. Similarly, the potential of increased retail sales costs due to custom-fitting requirements may be offset to a large extent by reducing the average time now spent in consumer fitting trials and/or by reduced inventory costs associated with stocking fewer size-width tariffs. It is in the area of retailing, however, that the principal barriers to this innovation are thought to be present. This is one reason that emphasis is given to the innovation strategy.

The innovation strategy must be the product of a process that defines the respective roles for the various components of the shoe industry and the government. At this stage of concept development these roles are hard to define because the objectives and prerogatives of the public and private sector are different in a fundamental sense. If, however, it can be agreed that an innovation like the Custom-Fit Concept has merit and leadership for its development emerges in the various trade associations that link the industry, then the problem of role definition can be engaged head-on.

If the innovation sought here was based on the development of a particular item of production equipment, it is easier to see that government-industry arrangements could be made to complete development, dispose of attendant property right questions, and have the commercial introduction of the equipment to one or two firms in the sector. The Custom Fit Concept must finally be introduced by retailers, by the thousands if the concept is to have any impact. It is apparent that the innovation strategy must be formulated so as to lead to this scale of retailer involvement. This cannot happen in the short-run without the use of federal funds outside the traditional areas of R&D. The discovery of how to shape federal involvement beyond the traditional R&D stages is the reason for defining the respective public and private roles in the innovation. The barrier to innovation so addressed in such a role definition effort is that of ensuring coupling between technology development and the technology delivery system.

3. Cooperative technology development. Given that a strategy for innovation is developed and the respective roles of industry and government are defined, the areas for cooperative technology development appear to fall into two main categories. The first category is concerned with the materials and techniques for delivery of custom-fitting, and the second category is concerned with building the infrastructure necessary within the manufacturing, retail and supply components of the industry.

The principal advantage in government participation in the technology development is to assure that the development of insert materials achieves the greatest possible patent protection. This protection will help ensure that the technology is licensed to domestic manufacturers to the exclusion of foreign manufacturers. The development of insert materials would involve extensive programs for formulation and evaluation of materials to establish characteristic and practical performance limitations. Such a program is beyond the resources of the industry. In a related sense, government participation in the development of manufacturing techniques will also help ensure that the methods developed to incorporate insert materials are standardized from the retailers' perspective.

One joint study area that is thought to be an essential part of building infrastructure concerns the conduct of a comprehensive fitting study. This study would determine, among other factors, the extent to which the Custom-Fit Concept is significant to consumers because of their fitting problems. The study should be patterned after the Fort Knox investigation and should be designed to help the industry recognize where in the spectrum of footwear manufacture and retailing the concept should be first introduced to maximize the chances of successful introduction.

Other areas for cooperative development of infrastructure include personnel training, field trials, design computations (to maximize the potential impact of the concept), styling assessments, and, to the extent feasible, marketing studies.

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FINAL REPORT

MANUFACTURING TECHNOLOGIES FOR THE U.S. NONRUBBER FOOTWEAR INDUSTRY

IITRI Project No. J6440

May 15, 1978

Report prepared by:

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TABLE OF CONTENTS

* Deleted from Proceedings

I. INTRODUCTION

The U.S. nonrubber footwear industry's current share of the domestic market is less than 50 percent. It is possible that many factors account for this situation, i.e., availability of capital, marketing problems, government policy, manufacturing technology utilized, etc.

It is the purpose of this investigation and report to explore only the factor of manufacturing technology as it can be related to the U.S. nonrubber footwear industry.

In response to a request by NBS (M. King to IITRI dated January 16, 1978) IITRI submitted a proposal (78-244J) to the U.S. Department of Commerce. The proposal was accepted and Purchase Order No. 808204, dated March 8, 1978 was issued to IITRI by the National Bureau of Standards to perform the effort outlined in the proposal.

This report fulfills the first requirement listed under Task IV of the purchase order.

II. FACILITY VISITS

A. Visits to Shoe Manufacturing Facilities

The following companies were selected to afford an opportunity to view several key dimensions for the shoe manufacturing process: 1) size of plant; 2) type of shoe, i.e., men's/women's, style/work; 3) length of run; 4) single/multi store; 5) single/multi plant 6) line/staff interview; 7) various levels of management and 8) various midwestern locations, i.e., Wisconsin, Ohio, Illinois and Kentucky.

Throughout emphasis was on observing current operations from the point of manufacturing process and systems technology. The efficiency of current techniques, methods and technique was observed primarily by drawing on the skills, and concepts of mechanical, industrial, and systems engineering, computerization and automation.

To complement the visits listed below, information was collected by mail from several equipment and component manufacturers.

1. Visit to Jung Shoe Manufacturing Company, Sheboygan, Wisconsin, April 10, 1978 - by E. C. Young, (IITRI).

On this visit, Henry Jung, President was interviewed. Mr. Jung also toured his plant with Mr. Young and explained many of the problems he currently faces.

This visit afforded an opportunity to observe a small scale manufacturer of men's footwear marketing in a variety of markets, i.e., industrial and farm workshoes, pull-on boots, sports-related shoes, and forestery/logging shoes. These markets are not as hard hit by imports as those in women's shoes, but they still involve many of the typical problems which a small shoe manufacturer must face. These include: 1) escalating costs of labor and materials, especially labor, short production runs, frequent changes in operations. Jung Shoe uses the Goodyear Welt construction which to date has not been as trade impacted as cement lasted shoes.

2. Visit to Levereng Shoe Company, Sheboygan, Wisconsin on April 10, 1978 by E. C. Young (IITRI).

An initial interview was held with Robert H. Levereng, Board Chairman and Kenneth C. Balsing, Vice President, Manufacturing. This allowed further exposure to the problems besetting a smaller sized United States men's shoe manufacturer.

Levereng Shoe Company operates two plants outside Sheboygan. Mr. Balsing conducted Mr. Young on a tour of the plant at New Holstein. This is a modern one-story operation and served to point up the efficiencies which a company is able to achieve by emphasizing machine layout, work flow and material handling.

3. Visit to Weyenberg Shoes, Beaver Dam, Wisconsin, April 11, 1978 by E. C. Young and R. Kasparas (IITRI).

Weyenberg Shoe afforded an opportunity to visit a plant in a medium sized men's shoe company operating several plants. The operation visited was larger than either Jung Shoe or Levereng and thus provided another perspective on men's shoe manufacture.

Following an interview Terry A. Lee, General Superintendent of Manufacturing, took the IITRI team on a detailed and very thorough tour of all operations in the Beaver Dam plant. Operations of particular interest were the leather stock room and cutting, due to the high standards maintained for both leather and the cutters. The potential loss in this area is especially great due to the large amount and high cost of leather used in a pair of Weyenberg shoes. Opoortunities for centralized administrative, service, and warehouse functions in Milwaukee were of interest (although not visited at this time).

4. Visit to Florsheim Shoe Company, Chicago, Illinois, April 20, 1978, by E. C. Young and R. Kasparas.

This visit was arranged by George McDorman, Director of Men's Shoe Manufacturing. It included a thorough tour of operations with John Mirabelli, Plant Superintendent. Again, all operations were observed in some detail. This was the largest men's shoe plant visited, and is also operating in a high labor cost market (Chicago) and this locational disadvantage serves to underscore many of the labor problems besetting the United States shoe industry, i.e., wage and fringe escalation, turnover, lack of interest in the shoe industry, etc.

5. Visit to W. M Greiner Company, Chicago, Illinois on April 20, 1978, by E. C. Young and R. Kasparas (IITRI).

This visit was included to get a better understanding of the interface between the tanner and shoe manufacturer of one of the chief materials in which the United States has a natural advantage -- leather.

This visit included an interview with Dirk Anderson and subsequently, a tour of the facilities in Chicago. The larger potential savings in the use of leather had initially prompted this visit.

It remains as an open challenge as to just how much this market interface can be standardized, or the tannery further included in the grading and sorting process, but the escalating cost of leather and the United States advantage in this commodity, point to the need for further investigation into the problems and prospects for better leather grading and utilization.

6. Visit to Dr. Scholl Shoes, Falmouth, Kentucky, April 27, 1978, by E. C. Young and R. Kasparas (IITRI).

This visit was arranged by the Chicago Office, and consisted of tour of facilities with Roy Bryant, Supervisor. Following the tour interviews were held with David Hart, Industrial Engineer and Jerome Gallenstein, Plant Superintendent.

This visit afforded an opportunity to visit a modern, air-conditioned plant designed especially for women's shoe manufacture. While there are limitations to the amount of re-arrangement and combining that can be done due to present equipment design, the material handling system of interest since it was designed to integrate several manufacturing and warehouse operations.

Heretofore, the possibilities in applying such modern warehousing techniques had not been observed in any of the IITRI visits. Due to the style, size, and width variations in the shoe business, coupled with the limited runs due to average company size and marketing practices in shoes, the opportunity for savings or other forms remain a question. In the case of Dr. Scholl, ownership of some retail outlets and stable shoe styles permits this modernized warehouse.

7. <u>Visit to U.S. Shoe, Cincinnati, Ohio on April 26, 1978 - by E. C. Young and R. Kasparas, (IITRI)</u>.

This visit was arranged by Robert Stix, V.P. Manufacturing. Three facilities were toured with Peter Bradford, Industrial Engineer. The large scale of U.S. shoe, the administratives, technical, and operations support center in Cincinnati makes possible many advantages not possible to the smaller, single plant shoe operations. For example, components manufacture, large scale purchasing, the critical size and grinding levels necessary for R&D, testing, and new product development.

This visit allowed an opportunity to observe the cement last construction which predominates in women's shoe manufacture, multi-plant operations, and the industrial engineering perspective, e.g., through Mr. Peter Bradford. Plants visited included those at Flemingsburg and Maysville, Kentucky and Ripley, Ohio. The visit to Maysville afforded an opportunity to observe women's boot manufacture.

B. Other Visits

1. Symposium on Footwear Industry Concepts

This symposium was organized by the U.S. Shoe Corp and held in Cincinnati, Ohio on April 4 and 5, 1978. The theme of the symposium involved general discussions of the problems facing the footwear industry by

N. Germany - Research & Development American Footwear Industries Assn.

R. Stix - V. P. Manufacturing, U.S, Shoe

D. Ross - U.S. Shoe

D. Letch - Technical Director, U.S.M. Corp.

D. Thayer - CAMSCO

F. Haynes - GAO

R. Messenger - Cincinnati Milacron

H. Winkler, President of the University of Cincinnati outlined how the university would apply its resources to establishing and operating a footwear technology center.

The details of the symposium are recorded in an NBS memorandum for file by M. King, dated April 11, 1978, A copy of this memorandum is appended hereto.

2. Visit to United Shoe Machinery (USM), Beverly Mass., May 9, 1978 - by G. Putnam (IITRI). This visit involved reviewing the technology USM has recently developed or is developing to reduce the costs involved in shoe manufacturing. The applications reviewed were:

- Numerical Control Stitching
- Numerical Control Bar Tacking
- Nesting and Cutting Shoe Bottoms
- Semiautomatic Lasting Machinery
- Shop Handling Systems

III. RECOMMENDED TECHNOLOGY APPLICATIONS

A. Marking (Stitch Marking and Printing)

1. Current Method

After the various parts of an upper have been cut, it is necessary (1) to mark, then to identify where parts are to be joined; (2) to identify, when to stitch and; (3) to identify the case number, size, width and match number. The match number is placed close to the edge of the part in a position where it will be hidden when assembled. The purpose of this number is to insure that all the parts for a given shoe can be kept in the correct sequence when the lot is stitched.

Marking of joining and stitched lines is usually done using simple techniques. One method is to place a template slitted according to the appropriate joining and stitched lines on the component and to mark these lines using the slitted guides. A second method requires that the component to be marked be placed in fixture positioned in front of a marking die which can be lowered by hand to mark the component and which retracts to an inking pad while the componet is removed and new ones (at times two pieces simultaneously) are positioned for marking.

Lastly, marking numbers on upper components and lines is done using a stamping machine which is hand set, each time the shoe size and width is changed. When each run is finished the case number is also changed.

2. Current Cost

Special costs of these operations in a plant employing 350 direct time workers and producing 4,000 pairs/day is calculated as follows:

1. Marking joining and stitching lines averages 3-4 employees

2. Stamping case numbers, sizes, widths and matching numbers on uppers averages 3-4 employees

3. Stamping liners 1-2 employees

4. Total employees on marking averages 7-10, or between 2 percent and 2.8 percent of total direct labor cost.

5. Since this will vary greatly depending on the styles produced, an average of 2 percent is used.

6. Assuming $2.03/pair of direct labor cost, total marking cost runs at least $.04/pair, or

7. For a plant averaging 4,000 pairs/day for 250 days/year or 1,000,000 pairs/year, the marking cost/year is $40,000.

8. Based on a total annual production, U.S. production of 416,566,000/pairs, this amounts to a total labor cost of $16,662,640.

3. Applicable Technology

The technology to be applied to these operations involves

- incorporating marking devices in the cutting die
- using impact matrix printing
- minicomputer technology

4. Cost to Develop Technology

All of this technology exists. Therefore, there is no cost to develop it. Packaging the technology for this application is estimated to be less than $40,000.

5. Proposed Method

This application relates very closely to the described recommendation for Parts Nesting and Die Cutting.

Referring to Figure 1 it can be seen that the table moves underneath a matrix type printing head which can be computer controlled. Input to the system consists of order information in addition to the nesting information which is required by the parts nesting and die cutting operation. This can be entered via the cards which are currently keypunched for each order.

The ink used would be the "ultra violet" type to eliminate the need to apply the marking to areas which are hidden.

The printing head would be the "matrix" type to minimize cost.

6. Cost Effectiveness

Based on current similar equipment the following are cost estimates for the equipment required (in addition to the equipment required for Parts Nesting and Die Cutting:

• Printing Head (matrix type) and Keyboard	\$15,000
• Added Software	10,000
• Installation and Debugging	5,000
	\$30,000

Savings:

50 percent of marking costs (.5 x 40,000)	\$20,000

Increases:

Added cost for ink	\$ 5,000
Programming maintenance	\$ 2,000
	\$ 7,000

Net Annual Savings (20,000-7,000)	\$13,000

$$\text{Payback Period} = \frac{\text{Capital Costs}}{\text{Annual Savings}} = \frac{30,000}{13,000} = 2.31 \text{ years}$$

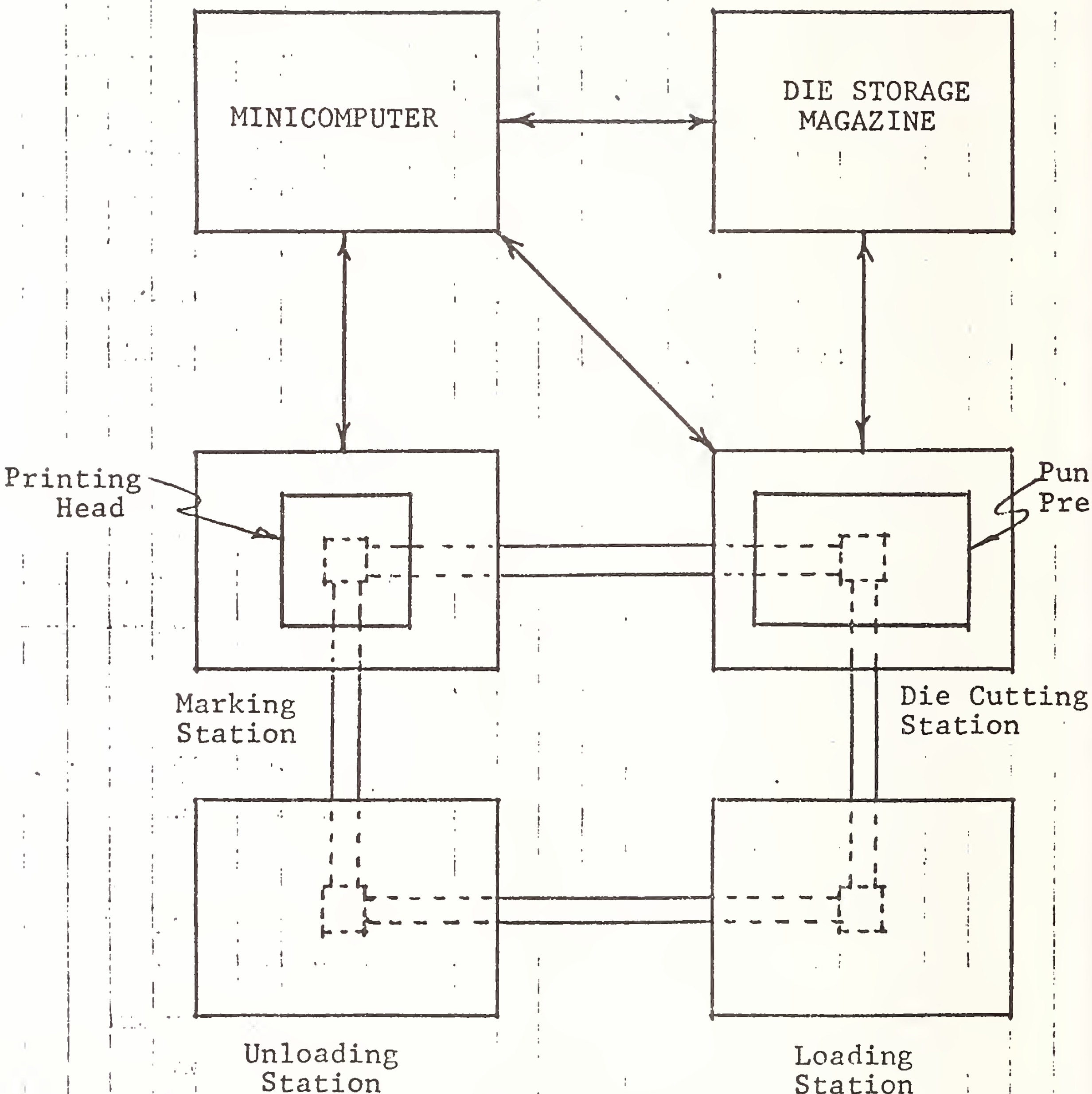

Figure 1. Die Cutting and Marking System

7. Implementation Barriers

- Lack of familiarity with computer technology by shoe manufacturers
- Lack of service bureaus for manufacturers who have no computer facilities

Shop Floor Reporting

1. Current Method

Since shoe factories work on a piecework basis, it is essary to maintain a record of all pieces completed on each sured operation by each worker. Usually, this involves a lection of individual work tickets by each operator for the ts/operation he (or she) completes. These work tickets are ut 1/1" x 2" and each operator has a folder or booklet in which y are assembled.

Typically at least in shoe factories visited, each worker ords units completed at each piece price and extends these to ain his (or her) daily pay. The payroll clerk must also deter- e individual pay rates using this same information to make a al payroll calculation.

Since as many as 60 operations are performed in the fitting m alone; since runs are typically short, and since many shoe les are run each day, it is necessary to make hundreds of these culations to arrive at the daily payroll.

2. Current Cost

Cost of collecting this information is calculated as follows:

1. Assume approximately 10 minutes per day, or 2 percent of total direct time, recording work completed on each operation, placing work tickets in a folder or booklet throughout the day; and extending and totalling these calculations at the end of the day.

2. Assume a direct labor cost of \$2.03/pair, 2 percent total direct labor cost runs about \$.04 per pair.

3. For a shoe factory producing 1,000,000 pairs of shoes/year, this amounts to \$40,000 annually.

4. Based on a total U.S. shoe production of 416,566,000 pairs/year (1977), this amounts to a total cost of \$16,622,640.

3. Applicable Technology

All of the data collection and recordkeeping activity going on in the fitting, lasting and other departments can be eliminate and replaced by a central computer which could accept the input, classify it, perform associated operations and convey the information to the production control center, planning center, payroll and other departments that could benefit from such data. All this can be simply achieved by equipping work areas with a miniature computer terminal capable of accepting a few numbers such as the ID number of the operator, the code number of the task performed, the number of lots, etc. Some operators could be equipped with portable input devices to permit production flexibility in terms of available operators and tasks.

4. Cost to Develop Technology

There is no cost to develop this technology. It exists. The problem involves applying the technology.

5. Proposed Method

Each operator would go to a terminal, insert their identification badge (which is magnetically coded) and key in the required information to indicate the jobs performed.

This information would be processed by a software program and combined with information extracted from the time standards data base to determine:

piece rate wages
job order status

6. Cost Effectiveness

Initial Investment

Shop floor reporting hardware	
15 terminals @ \$3,000	\$45,000
Minicomputer (similar to PDP 11/04)	\$25,000
Software	\$10,000
	\$80,000

Savings

50 percent of Direct Labor (.5 x 40,000)	\$20,000

$$\text{Payback Period} = \frac{\$80,000}{\$20,000} = 4 \text{ years}$$

7. Implementation Barriers

- Lack of investment capital
- Lack of incentives for capital investment

C. Materials Joining

1. Current Method

Pieces of the upper are joined together in the fitting room primarily by stitching them together. (In the case of thermoplastic materials, high frequency heating operations are well known although apparently not widely applied.) In the case of leather, the only method of forming observed or discussed with the IITRI team, was stitching. This is accomplished by individual operators using sewing machines. Parts to be stitched together are positioned by hand or positioned in a fixture when numerical control stitching is employed.

2. Current Cost

1. Assuming that fitting requires 38.2 percent of total direct labor and that approximately 35 percent of the fitting room labor includes some joining operations, the cost of joining is calculated as follows:
   - (a) 38.2% x 35% = 13.4%
   - (b) at $2.03 direct labor cost per pair of shoes, stitching which includes joining =
     $2.03 x 13.4% = $.272/pair
2. Assuming that a plant which has 350 direct labor employees produces 4,000 pairs/day and works 250 days, the yearly cost of stitching which includes joining is calculated as follows:
   - (a) 4,000 pairs/day x 250 days = 1,000,000 pairs/year
   - (b) 1,000,000 x $.272 = $272,000
     (annual cost of stitching including joining)
3. Total cost of joining in the U.S. shoe industry, assuming a total production of 416,566,000 pairs/year (1977) = $115,388,782.

3. Applicable Technology

The leather in the process of shoe production normally is oined by sewing in lock or chainstitch mode. Presently many other perations, such as attaching of lining, insoles and soles are one by means of adhesives and hotmelts. Besides stitching and lueing, leather could be joined by other methods, provided ertain developments take place. For example, ultrasonics is a ell understood and widely used technique to join thermoplastic aterials in the apparel industry. Nylon and similar thermoplastics oined by this method are common. Bathing suits, brassieres and ll types of under and outerwear have been manufactured with this echnology for the past 10 years. Fabrics and leather impregnated ith thermoplastics could possibly be joined by this method. Methods o impregnate leather for suitable joining could be a major break-hrough for the shoe industry. Since ultrasonic "sewing" eliminates hread, needle, bobbins, thread sensing devices, etc., the method o "thermoplasticize" leather, manmades and other materials could ave a major impact on the shoe manufacturing process. Another oining process that could be of significance is the process known s liquid thread.

The success of hotmelt adhesives in applications ranging from eal-bonding of flexible film packages, structural bonding of aminates and composites, and protective coating for plastic metal, ood, paper, leather and other natural and synthetic materials is ell documented. This success has been due primarily to the inge-uity of polymer chemists in developing adhesive formulations ailored for cohesive and adhesive strength and elasticity in the olid state while maintaining adequate viscosity, tack and wetting bilities in the molten state. This process has resulted in a ide selection of hotmelt polymeric materials with inherent strength roperties that can be employed in the design process as primary tructural elements.

IITRI proposed to employ this technology and the materials in a novel application for forming a basic textile seam. In applications useful in the shoe industry it could be useful in replacing long straight seams such as are required in sewing uppers of boots, boot zippers, etc. The method is to perforate the component pieces of leather with needles and inject these perforations with "thread" in liquid form. The material solidifies immediately and assumes the function of regular thread in appearance and otherwise. Only experimental work has been conducted so far. Thread material and equipment must be developed. <u>This is not a decorative stitch</u>.

Another approach to make joining of leather more efficient is to improve or modify the presently used sewing. Presently, two kinds of stitches are used: lockstitch and chainstitch. Lockstitch is preferably used because in case of thread rupture, the stitch does not come apart as is in the case of the chainstitch seam. Some time could be saved if instead of lockstitch, chainstitch could be used. Bobbin changing time could be used to sew productively. To prevent the chainstitch from coming apart, a thread impregnated by thermoplastic material could be used. For example, after sewing in usual manner, the chainstitch could be heat treated to fuse the thread at points in contact thus making the stitch impossible to "run" and come apart.

4. <u>Cost to Develop Technology</u>

While it is almost impossible to predict exactly what it will cost to develop a process to impregnate leather, devise a method and develop the liquid thread material or what it will cost to develop thermoplastic impregnated thread, it is anticipated that the three processes could cost about $100,000 to develop.

5. <u>Proposed Method</u>

The actual savings employing impregnated leather, however, could be significant because in addition to replacing the stitching by thread, other areas could benefit also. For example, all liners could be attached by ultrasonics thus eliminating hotmelts, glue pots, etc. Ultrasonics could save up to 25 percent of time presently required in the sewing and fitting rooms.

Less significant savings can be expected from the liquid thread, since its application is strictly in sewing of uppers, preferably straight portions. However, it is conceivable that the method could evolve above presently envisioned applications such as "sewing" of the entire upper in one shot, that is, in about one second of time or less. Normally, depending on the length of seam, liquid thread could save as much as 50 percent of time. For example, a zipper in a full length boot could be sewn in one second against the present time of approximately 60 seconds.

The cost savings with impregnated thread are not so obvious. First, the elimination of bobbins would probably save only a few percentage points of time, however, the elimination of the second thread can be very cost effective, since the danger to run out of thread while halfway along a seam, is eliminated. Further, all of the administrative procedures associated with bobbins are eliminated. All of these advantages combined could make the development of fuseable thread very cost effective, especially considering that no new sewing equipment is necessary for the material.

6. Cost Effectiveness

a. Boot Making Plant

(1) Initial Investment (liquid thread equipment)
5 units (operate 3 shifts) @ 18,000 90,000
*unit = injection molding machine and supporting tooling

(2) Annual Costs

Savings

- time to sew zipper
  present method = 150 seconds/pair

- time to attach zipper
  proposed method = 90 seconds/pair

  savings 60 seconds/pair
  or
  1 minute/pair

- percent time savings = $\frac{60}{150}$ = 40%

- current number of operators to sew in zippers in plant making 4,000 pairs/day =

  $$\frac{4{,}000 \text{ pairs/day} \times 150 \text{ seconds/pair}}{3{,}600 \text{ seconds/hour} \times 8 \text{ hours/day/operator}} = 21 \text{ operators}$$

- proposed number of operators =
  21 x (1.00 - .40) = 13 operators

- number of operators saved - 21-13 = 8

- value of savings = 8 $\frac{\text{operators}}{}$ x 2,080 $\frac{\text{hours}}{\text{year}}$ x \$3.50 per hour

  (avg. wage) x 1.25 (fringe benefit factor) = \$72,800

- added costs

  maintenance \$10,000

- net savings = 72,800 - 10,000 = \$62,800

(3) Payback Period

$$\frac{90{,}000}{62{,}800} = 1.43 \text{ years}$$

b. Other Plants (ultrasonic joining)

(1) Initial Investment

20 ultrasonic sewing machines
(multishift operation) @ 5,000 = \$100,000

(2) Annual Costs

- save 7.5% of fitting room labor
  .075 x \$6.85 x .296 (labor %) x .382 (fitting%) x

  $$4{,}000 \ \frac{\text{pairs}}{\text{day}} \times 250 \ \frac{\text{days}}{\text{year}} = 58{,}090$$

- added maintenance = 10,000
- added production control = 10,000
- Annual Net Savings = (58,090-10,000-10,000)
  = 38,090

(3) Payback Period $= \frac{100{,}000}{38{,}090} = 2.63$ years

7. Implementation Barriers

- Research and Development Risk - the development may not be feasible (impregnation of leather)
- Consumer acceptance of "no stitching" or "psuedo-stick" marking
- Lack of investment capital
- Lack of investment incentives

8. Miscellaneous

Contrary to impregnation of leather, much less technical ifficulties are anticipated with the liquid thread method. Some reliminary research has already been done at IITRI and some aspects f the method are well known and understood. We anticipate no roblems in the development of materials to meet the performance pecifications. Obstacles to be overcome are mainly in the design nd engineering of equipment.

Least difficulties are anticipated with the development of npregnated thread. In the worst case, a monofilament synthetic aterial could be used to satisfy the need for fuseable thread.

D. Grading, Nesting and Die Cutting

1. Current Method

(a) Grading leather and establishing grade boundaries

The current method of leather grading can be reviewed as a two-step process. First, in the leather room (aside from central leather processing units for multiplant operations) hides are inspected on a visual and tactile basis to determine if they have the attributes, i.e., color, density, texture, and surface qualities, required for a given shoe production order. If so, the square footage is tabulated and the hide assigned to the order.

A second aspect of grading occurs when the cutter positions the dies for the various parts of a shoe upper on a given hide. In this process of visually nesting the various dies on a given hide, the cutter is attempting to do several things simultaneously (1) match desired qualities in the part being cut with the appropriate portion of the hide, i.e., the vamp from the upper section of the hide; (2) avoiding irregularities, scars, branding marks, etc., and (3) minimizing leather losses in the process of attempting to do (1) and (2).

These methods have the advantage of low labor costs, but the material costs are likely to be high due to suboptimal leather utilization. Since leather grading is usually accomplished simultaneously with the process of sorting and measuring hides for appropriate shoe orders, grading time *per se* is not easily separated. Also, since most of the grading costs attributable to the cutter are closely related to his (or her) ability to cut efficiently material costs of grading are included under Nesting parts, die location and selection, and N/C stamping. Grading costs in the leather room are omitted from any calculations of current operating costs.

(b) Nesting Parts, Die Location and Selection, N/C Stamping

Currently, hides are cut individually into the various parts of a shoe upper by cutters using dies and stamping out parts singly at cutting press (Clicker Machine). When an order is received with a bundle of hides, the cutter will position a single hide on the Clicker table, select the appropriate dies from nearby racks and using the first die begins to cut the hide. This is done by swinging the beam of the cutting press over the die. The machine is then tripped to press the beam on the die. During the cutting process the cutter is always engaged in applying his (or her) own cutting algorithm. In theory two excellent cutters may vary somewhat in how they place individual dies on a given hide, but it is felt that there will be little discrepancy in the loss per hide. However, since there are no objectives grading standards on nesting patterns designed for each hide, there is no way to measure the extent of the current loss in material.

2. Current Cost

The cost of cutting varies greatly depending primarily on the mix of leather and man-made materials and the extent to which the latter process has been mechanized (e.g., cutting presses with traveling heads). Various estimates of cutting costs were obtained both by the DOC teams as well as IITRI staff members. These ranged from 5% to 12%. Costs of cutting are not directly proportional to the number of employees, since the pay rate on this job is one of the highest in the plant. With these qualifications current cutting costs are calculated as follows:

(1) Assuming a leather cutting cost of 8.7% of total direct labor, and direct labor costs of $2.03/pair, cutting costs/pair are $.1766/pair.

(2) In a plant employing 350 direct time employees producing 4,000 pairs/day and operating 250 days/year (or 1,000,000 pairs/year) this results in a total annual cutting cost of $176,600 per plant.

(3) Assuming a U.S. leather shoe production of 100,000,000 pair (approximately 25% of an annual production of 416,566,000 (1977) total cutting costs using present methods are $17,660,000 (100 x 176,600).

(4) The cost of material lost using the current method of cutting varies considerably depending on the development and implementation of leather specifications, nesting patterns, cutter performance guidelines, type of patterns cut, and leather "cutability". Estimates of loss varied from 5% as high as 15%. This wide range is due to the anticipation of the term "recoverable leather" due to improved cutter performance in grading and nesting dies effectively on each hide.

(5) Assume the following:

a. a recoverable loss of 5% due to suboptional grading and nesting by the cutter

b. a cost of leather of $1.20/square foot

c. 2 square feet of leather per pair of women's shoes

d. 3 square feet of leather per pair of men's shoes

e. 20% of total production is in shoes with leather uppers

f. 75% of the shoe production is in women's shoes

g. 25% of the shoe production is in men's shoes

h. a plant operating with 350 direct employees producing 4,000 pairs/day, operating 250 days, and producing 1,000,000 pairs/day

(6) Waste material in cutting uppers due to ineffective grading and nesting:

<u>Women</u>

(a) $\$1.20/ft^2 \times .05 \times 2\ ft^2/pr = \$.12/pr$

(b) 1,000,000 prs/yr x \$.12 - \$120,000/plant/year

<u>Men</u>

(a) $\$1.20/ft^2 \times .05 \times 3\ ft^2/pr = \$.18/pr$

(b) 1,000,000 prs/yr x \$.18 = \$180,000/plant/year

(7) Based on an assumed U.S. shoe production with leather uppers of 100,000,000 pairs/year, total waste material costs due to ineffective grading and nesting by the cutter are shown below:

<u>Women</u>

(a) .75 x 100,000,000 = 75,000,000/pairs
(or 75 plants with a capacity of 1,000,000 prs/year

(b) 75 x \$120,000 = \$9,000,000/year

<u>Men</u>

(a) .25 x 1,000,000 = 25,000,000/pairs
(or 25 plants with a capacity of 1,000,000 prs/year

Total lost material costs = \$13,500,000/year

(8) Total costs of cutting labor and lost materials due to suboptional grading and nesting by the cutter, based on an annual U.S. production of 100,000,000 pairs shoes with leather uppers =

cutting labor =\$17,660,000 (from (3) above)

leather loss =\$13,500,000 (from (7) above)

\$31,160,000

3. Applicable Technology

a. Grading

Automatic grading of leather is only necessary to enable the cutting of leather by automatic computer controlled means.

The purpose of grading in automatic cutting is to identify the areas of leather in a hide most suitable for vamps, side quarter, tongues, etc. This can be accomplished by scanning the hide for surface and texture imperfections with light emitting-collecting arrays and sound wave or infrared devices. A few of these techniques are discussed here for clarification.

Any surface when illuminated by light rays will reflect a certain amount of these rays or light. The amount of light that is reflected can be accurately measured by photosensitive cells or light sensors. These sensors can be arranged in groups of rows and are called light sensing arrays. Naturally, in order to sense or collect reflected light, it must first be emitted from some kind of source. Such light sources emitting infrared light* in the electronics industry are called light emitting diodes (LED) and can be compared to miniature flashlights. The LED are also arranged in arrays and placed at a required angle opposite to the light sensing arrays. In this type of setup each light source is matched with a light sensor to form many pairs placed next to each other for a given distance, depending on the object being evaluated. Sometimes the light emitting diode and the light sensor are assembled in a single unit but the operating principle remains the same as in separate arrays.

Leather used in the manufacturing of shoes, especially for the uppers, can be inspected by this method for surface imperfections. For example, the areas of branding, veins, scars and holes

*Infrared is mentioned as an example only. The light does not have to be infrared.

an be easily detected because they will normally reflect less or ore light than regular surfaces. This surface reflectivity infor-ation can be placed into a computer which in turn could either ark these surfaces to enhance visibility by the human eye or use his information to cut leather by computer controlled means.

Another simple technique to inspect the leather surface can e simply illuminating it by ultraviolet or other rays that pos-ibly could reveal surface information equivalent or superior to isible light. It could even reveal important information about he inner structure of the leather. At the present time, however, reliminary research is necessary to assess the feasibility of his approach. In order to grade leather for cutting, texture nformation is also necessary. To locate areas of different extures the leather can be scanned by air borne sound waves (ABSW). The method consists basically, of sending sound waves against one side of hide and measuring the sound on the other side. Higher density areas will suppress sound transmission more than areas of lesser density. These areas then can easily be identified and the information stored in the computer memory.

It is possible that leather texture can be scanned by infra-red rays of proper length. Presently this method of viewing or photographing is used in a wide variety of applications. For example, the U.S. Army employs infrared scopes on weapons used in night time warfare. Geological resource surveys employing this method via satellites are conducted to appraise numeral deposits, crops and similar applications. The underlying principle of the method is simple, since it amounts to "seeing" heat sources rather than images illuminated by normal lights. One such appli-cation appears to be in leather grading. It is well known that in a single piece of cowhide various areas of soft or hard leather can be detected by touch. These areas, basically, differ from each other in terms of leather density and thickness. A cowhide placed on a plate and viewed or photographed by infrared could reveal all of the necessary information on texture (in terms of density and thickness). The "image" or texture information then could be stored in the computer memory for subsequent utilization in cutting of leather.

In summary, then it can be stated, that combining a technique to scan the surface and the inner structure, a piece of equipment to grade leather, essential in the automatic cutting of leather, should be developed.

b. Nesting and Die Cutting

The key to material cutting is the ability to maximize the utilization of leather. In a computer controlled operation, where the nesting of dies would be done by numerically controlled machinery, the maximum utilization process requires specific information pertaining the leather about to be cut. This information we propose to obtain by leather scanner capable of locating and indicating the area of hide unfit for production. This information then would be used by the computer which by means of numerical controls would command a die handling system which would then perform the cutting operation. Mathematical calculations would be used to derive the most efficient nesting pattern. Vamps and other frontal pieces would be cut from the high quality areas while parts requiring lesser quality leather would be cut from appropriate locations. The actual cutting of pieces could be done by presses or similar equipment.

- Cost

The significant part of the process described above is the die handling device which may be a machine, a mechanized fixture or an industrial robot. This system or device must be coupled to a computer capable of accepting information from the scanner, capable of performing necessary calculations, and capable of controlling the die handling device.

4. Cost to Develop Technology

Since most of this technology exists, no major development effort is required. To combine existing technology and develop an application package is estimated to be \$125,000 to \$150,000.

5. Proposed Method

The proposed method involves using a computer program to nest parts in a given area of flat material (applies to both leather and "man-made" material). The nesting system would accept the material area configuration and the outline of the parts to be cut as inputs. The nesting algorithm would orient a group of parts to be cut within the usable material area such that minimum material waste would result. Nesting algorithms and corresponding software have been developed for such industries as sheet metal fabrication, clothing manufacturing and shipbuilding.

Individual part configurations would be generated by digitizing drawings of the parts.

A hardware system similar to that shown in Figure 1 would have to be developed. The system would contain 4 stations.

a. Loading - the material would be fastened to a pallet and placed on a table in a fixed orientation (recognized by the minicomputer)

b. Die Cutting - the table would move under the punch press. Based on a computer software program a die would be selected from the Die Storage Magazine and loaded in a die holder in the punch press. The die holder would rotate to the strike position and the table would be properly positioned in the "X-Y" plane such that when the press actuates the die will cut the proper part in the proper location.

As the press is actuating another die is being placed in a second die holder.

When the press actuation cycle is complete the "old" die is returned to the die storage magazine as the "new" die is swung into position and the press actuated. This is a standard numerical control tool changing procedure to maximize machine tool utilization.

Incorporated in each die would be characters to be punched into the material that are associated with the die (i.e., size). This identification would be placed on the material during the punching cycle.

6. Cost Effectiveness

a. Initial Investment (based on similar existing equipment)

o Minicomputer (similar to PDP 11/34) and software	$100,000
o Punch press, die storage magazine, network of tables with 4 positions	250,000
o Grading equipment	25,000
o Installation, training	25,000
Total Initial Investment	$400,000

b. Annual Costs

Savings

Material - 8% (based on USM studies)

$$08 \times \$6.85 \frac{\text{avg. cost}}{\text{pair}} \times .392 \text{ (material position)}$$

$$\times 4{,}000 \frac{\text{pairs}}{\text{day}}$$

$$\times 250 \frac{\text{days}}{\text{year}} = \$214{,}816$$

Labor - 10% due to deskilling and faster operation

$$.10 \times \$6.85 \frac{\text{avg. cost}}{\text{pair}} \times .296 \text{ (labor portion)}$$

$$\times .087 \text{ (cutting labor portion)}$$

$$\times 4{,}000 \frac{\text{pairs}}{\text{day}} \times 250 \frac{\text{days}}{\text{year}} = \$17{,}640$$

Increases

Programming Labor $5,000

Maintenance Labor $5,000

Net Savings = 214,816 + 17,640 - 5,000-5,000 = 222,456

c. Payback period

$$\frac{\text{Initial Investment}}{\text{Annual Savings}} = \frac{400,000}{222,456} = 1.8 \text{ years}$$

7. Barriers to Implementing

1. Providing incentives to machine tool builders to produce the required machinery
2. Availability of capital to shoe manufacturer
3. Lack of familiarity with numerical control by the shoe manufacturer
4. Lack of service bureaus to supply the required service to organizations who have no existing data processing facilities
5. Resistance to automation by labor force

IV. PRIORITY RECOMMENDATIONS

Letting the payback period be the governing factor in determining the priority for implementing the technology recommendations described in Section III, the rank order list in declining order of priority is as follows:

Grading and Nesting
Marking
Materials Joining
Shop Floor Reporting

V. AREA OF POTENTIAL GOVERNMENT INDUSTRY COOPERATIVE EFFORT

A. Technology Development Program

This program would be similar to the REAPS program for the U.S. Shipbuilding Industry.

The program would develop new technology for or apply existing technology to shoe manufacturing.

Shoe manufacturers and the U.S. government would jointly contribute funds and engage a contractor to administer the program.

The contractor would interact with the government and industry representatives to:

- identify areas of interest common to a set of shoe manufacturers
- assist in defining project specifications to fulfill these needs
- conduct or manage the development effort to execute projects which would respond to these needs according to the specifications developed
- monitor progress of these projects
- implement the developed technology in a production environment.

Such a program would permit the shoe manufacturing industry to:

- help itself improve productivity
- share development costs while still maintaining competitiveness in the application of this technology

B. Technology Diffusion Center

This would involve a project comprised of:

1. government
2. shoe manufacturers
3. shoe manufacturing technology suppliers

Direct funds would be supplied by the government and shoe manufacturers. The suppliers would participate in one of the following ways:

- providing equipment to the center at reduced cost
- lending equipment to the center
- donating equipment to the center

A contractor would be hired to organize and manage the center. The center's functions would be as follows:

- Training - in maintaining and operating the equipment and in conducting classes related to the technology such as computer programming systems management, equipment justifications, etc. "Hands-on" training as well as class room training would be conducted.
- Information Dissemination - shoe manufacturers would be able to access a single source to determine for a given subject area:
  - the training available
  - available suppliers
  - technical literature available
- Technical Meetings - an annual (or more frequent) gathering of educators, users, and suppliers related to shoe manufacturing technology for an interchange of ideas

'I. OTHER CONSIDERATIONS

The time and financial resources available to conduct this ›roject were severely limited. Therefore, it was not possible to .o much "in depth" analysis of shoe manufacturing and the tech- ıology that might be applicable to it. Consequently, the cost/ ›enefit analysis could only provide a rough indication of the :conomics involved.

It is hoped that these preliminary efforts will prime the :ffort to investigate the area of applying new and innovative :echnology to shoe manufacturing through the medium of one of the ;uggested areas of government-industry cooperation.

Final Report

Submitted to

National Bureau of Standards
Department of Commerce

on

MANUFACTURING TECHNOLOGIES FOR THE U.S. NON-RUBBER FOOTWEAR INDUSTRY

by

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Table of Contents

* Deleted from Proceedings (available upon inquiry)

SUMMARY

Footwear manufacturing consists of a large number of operations performed on many different parts involving flexible and irregular materials. Footwear is fashion dependent and therefore adaptive manufacturing methods are required. The materials' characteristics, lot sizes and fashion dependence have been barriers to increased mechanization. Thus, countries with inexpensive labor provide stiff competition, and they are aided by steady improvement in transportation and communication. For several U.S. companies it became more economical to import footwear from these countries than to produce domestically. The future existence of the domestic footwear manufacturing industry is thereby threatened.

The Laboratory for Manufacturing and Productivity of the School of Engineering at MIT performed a survey of footwear manufacturing technologies for the U.S. Department of Commerce. Footwear manufacturing plants, leather tanneries, retailers, trade organizations, a machine manufacturer, a die manufacturer and a last maker were visited in the U.S. and in Italy. The constraints imposed on the footwear industry by international competition and by technical and economical factors were determined through these visits and an analysis of statistical data. The following criteria for evaluating existing or newly-innovated manufacturing technologies were derived:

I. Effect on the cost of U.S. Non-Rubber Footwear products

II. Effect on style adaptation time

III. Effect on final products' materials and assembly qualities

IV. Effect on in house style perception and style inventiveness

V. Time lag anticipated between decision of implementation and effect on U.S. market.

Concepts and examples of productivity enhancing footwear manufacturing technologies fall into two categores: technologies with short term goals and technologies with long term goals.

1. Methods for improving the competitiveness of U.S. footwear manufacturing plants on a short term basis are:

    1.1 Materials Utilization: The materials cost component is so high that materials have to be used optimally. Systems to improve materials utilization in leather cutting include: cutting table improvements, equipment for better pattern nesting and simultaneous cutting.

    1.2 Testing of Materials: Lack of knowledge about material properties can reduce productivity significantly and lengthen the time it takes for introducing new styles. Some examples are given to demonstrate the role of materials testing in increasing productivity.

    1.3 Reduction of Manufacturing Systems' Information Content: Combining operations into one operation increases productivity when functional requirements are still satisfied independently. This and other axioms for increasing manufacturing productivity are under development in the Laboratory for Manufacturing and Productivity. They are explained and demonstrated by examples such as an integration of skiving and pinking and a combination of sole and heel trimming.

    1.4 Computer Assisted Management: This is a must for every modern shoe plant. Advantages of computer use are presented.

    1.5 Training: Technology improvement is required but proper training of new employees has to go along with it. The synergistic effect of training and technology on productivity is discussed.

2. Over a longer time, productivity can be increased through the following:

   2.1 Computer Aided Design(CAD): Computer systems are proposed to facilitate the design of shoes, lasts, dies and graded patterns.

   2.2 Computer Aided Manufacturing(CAM): Linking of these Computer Aided Design systems with computer controlled manufacturing processes results in significant reduction of style adaptation time. Concepts of computer controlled machines for last making, die making and cutting of materials are proposed.

   2.3 New Assembly Techniques: manipulation of components in stitching machines accounts for 75% of the labor costs in the fitting room. Preliminary ideas for new concepts in assembling flexible parts suggest that productivity may be increased significantly.

   2.4 Materials Research: The characteristics of leather have not been equalled by any man-made material. There is a need for new and recycled material. Recycling of leather and lasts are demonstrated by examples.

3. A Cooperative Footwear Technology Program

   Advances in productivity could be made in a relatively short time if a closer working relationship between several footwear manufacturing companies and a competent manufacturing research organization is established. This could be accomplished through a cooperative footwear manufacturing program. The goals and organization of such a program are presented.

Industries involved in a cooperative footwear manufacturing program will provide problems continuously and the program's research center must have the intellectual resources, financial support and motivation to solve them through innovation and analysis. Government's role in such a cooperative research program should be to evaluate its effectiveness and provide the necessary initial funding. The program must become self supporting by growth of the number of industrial members funding the program.

A cooperative polymer processing research program was started at MIT in 1973 with initial funding from the National Science Foundation and financial support from three corporations. This program grew to a large cooperative program completely funded by twelve corporations. A continuous output of innovations with non-exlcusive patent rights to the member companies results from the effort of more than twenty researchers at MIT. A footwear manufacturing technology program would be modeled after the Polymer Processing Program and would benefit from experience gained from it. Hopefully, such a program will help U.S. footwear manufacturing regain its competitive position.

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INTRODUCTION

The technological issues involved in increasing the productivity of the footwear industry have been examined by the MIT Laboratory for Manufacturing and Productivity for the Department of Commerce over a period of two months, from March 15 to May 15, 1978. The goal of the study was to evaluate modern manufacturing methods for application in the U.S. non-rubber footwear industry.

The initial project effort consisted of gathering information about the footwear manufacturing industry, footwear manufacturing machinery, leather making and retailing of footwear. Statistical data were analyzed in order to develop evidentiary background about problems identified by the investigators. This work was essential in establishing criteria for evaluation of new or modified technologies to be considered for the footwear industry.

The second phase of the project was concerned with conceptualizing and evaluating new manufacturing methods for the U.S. footwear industry.

The third phase of the project considered the advisability of establishing a cooperative footwear manufacturing research program. Each of the three phases is discussed in detail in a separate section of this report.

1. Criteria used in Evaluating Footwear Manufacturing Technologies

New technology can enhance the competitiveness of U.S. footwear manufacturers only when it is carefully selected and is designed to meet the specific nature of the industry's problems. Imported footwear from low labor rate countries is generally recognized as a major contributor to low industry profits, to employee layoffs and closings of manufacturing plants. Accordingly it was necessary to analyze the characteristics of selected foreign footwear industries so as to develop an insight into their major strengths.

On the domestic side, a determination was made of the technical and economical factors imposed on footwear manufacturers. During visits to U.S. companies and trade associations considerable data was gathered and analyzed.

As an outgrowth of the many visits, interviews and analyses, basic criteria have been devised for evaluating the potential of new footwear manufacturing technologies for the U.S. industry.

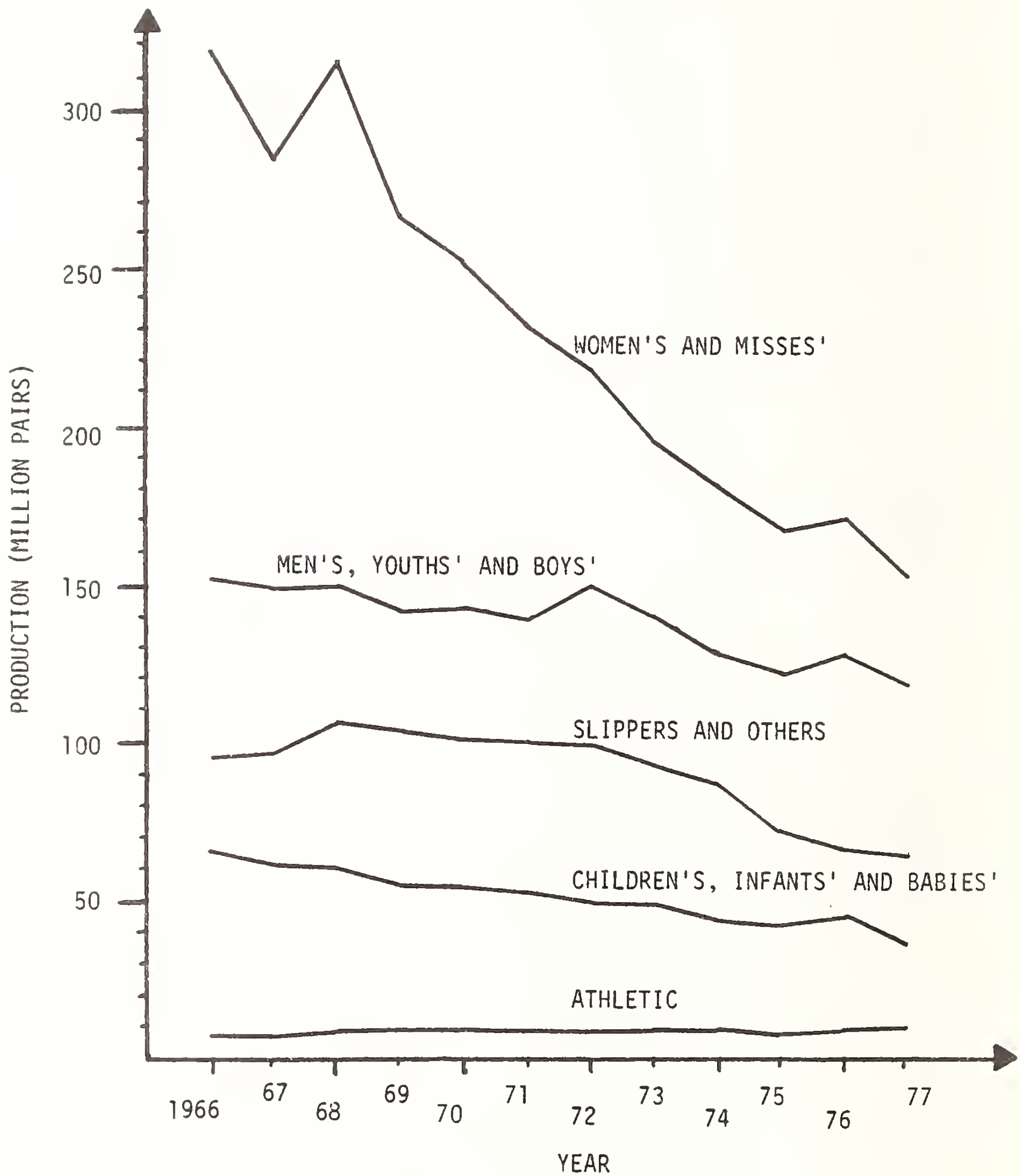
1.1 International Competition

A clear picture of the constraints international competition imposes upon the U.S. footwear industry can only be sketched after analysis of statistical data, study of the foreign competitors' products and observation of the economical and social environment of the foreign factory. Italy as the most important exporter of footwear (dollar value) into the U.S. has been examined most closely.

1.1.1 Analysis of Statistical Data

Production figures for several branches of the U.S. footwear industry are summarized for the period of 1966-1977 in Fig. 1. The downward trend for all markets, except athletic footwear, underscores the reason for labor, management and government concern about the future of footwear manufacturing for the United States. The total U.S. production of non-rubber footwear decreased from the annual production rate of 641.7 million pairs in 1966 to 395 million pairs

FIGURE 1 U.S. ANNUAL PRODUCTION OF NON-RUBBER FOOTWEAR (FROM REF. 1)



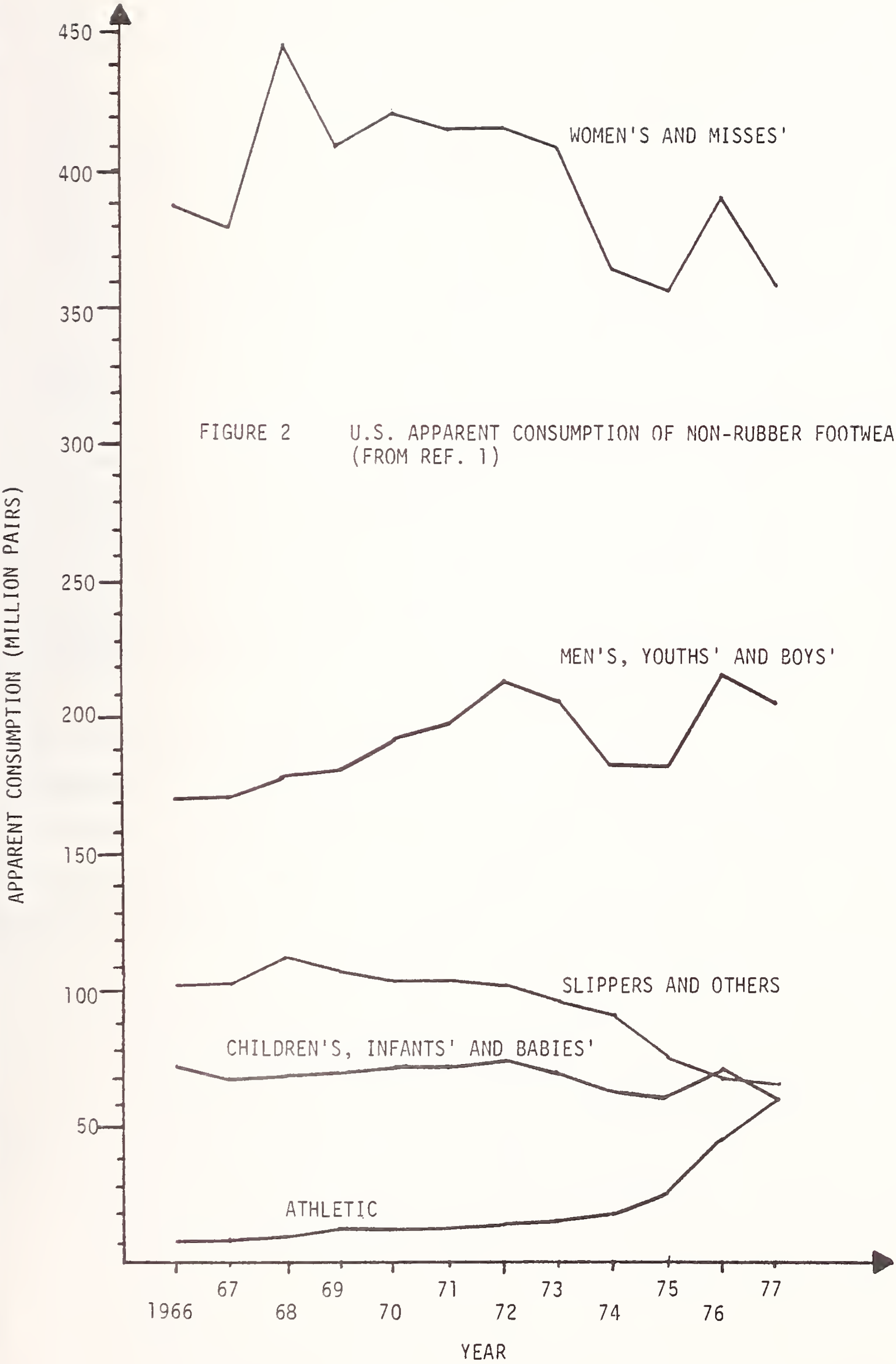


FIGURE 2 U.S. APPARENT CONSUMPTION OF NON-RUBBER FOOTWEAR (FROM REF. 1)

in 1977, a decrease of 40% in ten years. What is even more alarming is that there is no indication that this downward trend is going to change for the better in the years ahead.

Fig. 1 illustrates that the reduction in U.S. production of Women's and Misses' footwear which started more than ten years ago, accounts for the largest loss of all sectors involved.

Since only 1.5% of footwear produced in the U.S. is exported [4], the data in Fig. 1 in essence represents the consumption level of domestically produced footwear. The remaining consumption is provided by overseas sources. The sum of domestically produced and imported footwear (pairs) is reported in Fig. 2. A slight decrease in the total consumption of women's footwear and slippers, and an increase in mens' footwear and athletic footwear can be noticed. A comparison between Fig. 2 and Fig. 1 indicates that the U.S. lost a significant part of the women's shoe market and that in the men's and athletic footwear sector domestic production was unable to develop a significant share of the growing market.

Figure 3 is a plot of the quantities of imported shoes since 1960, which is the difference between the data shown in Fig. 2 and Fig. 1. An interesting revelation of these figures is related to the recession years 1974 and 1975. There was clearly a reduction of imported footwear and no abnormal reduction in domestic production. It might turn out to be important to understand the reasons behind this phenomenon.

By comparing the U.S. production with the production of seven countries of the European Common Market for the period '66-'76 one observes (Fig. 4), that the U.S. footwear industry suffered the greatest loss in absolute value of production, but on a relative basis countries like Belgium and the Netherlands lost a good deal more. In the same period Italy almost doubled its footwear production by exporting to the German Federal Republic (49.1% of export),

FIGURE 3 U.S. ANNUAL IMPORT OF NON-RUBBER FOOTWEAR (FROM REF. 1)

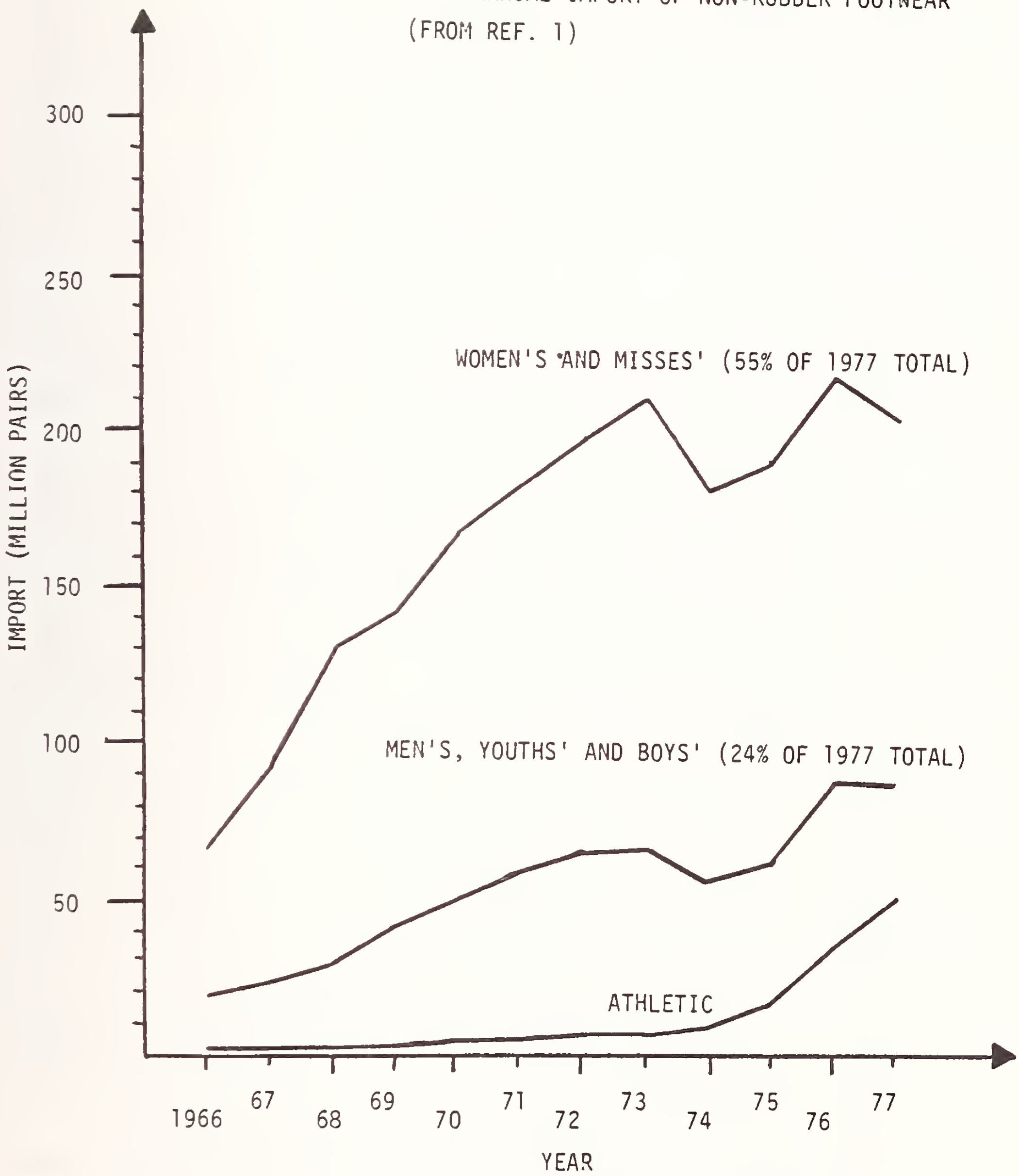


FIGURE 4 ANNUAL NON-RUBBER FOOTWEAR PRODUCTION OF DIFFERENT COUNTRIES (FROM REF. 1 AND 5)

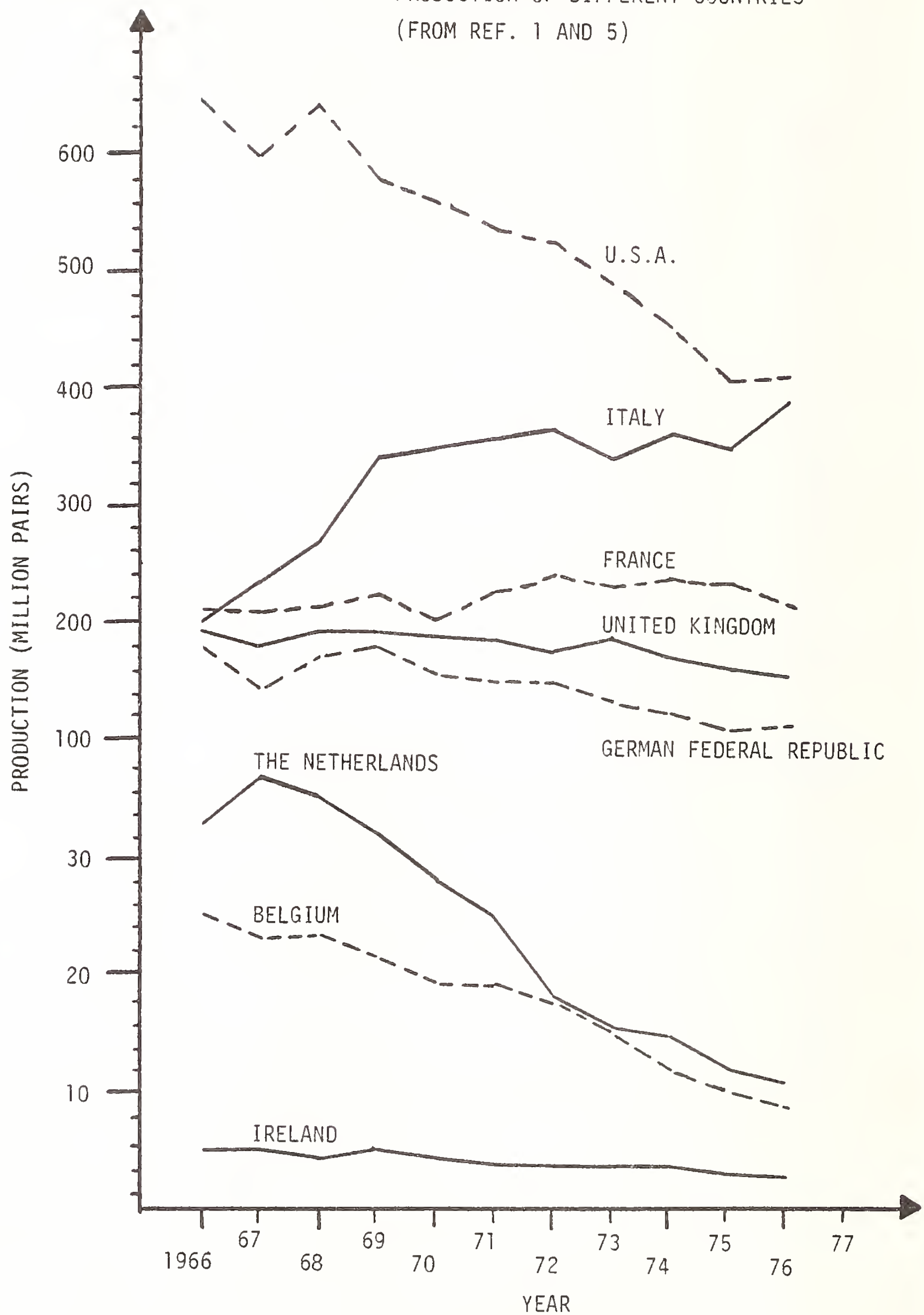


TABLE 1 FOOTWEAR TYPES WITH TOTAL IMPORT VALUE OVER $50,000,000 FOR YEAR 1976 (FROM REF. [1])

TYPE	COUNTRY	VALUE $ 10^6	PAIRS 10^6	AVERAGE $
WOMEN'S & MISSES' LEATHER	ITALY	180.4	26.8	6.71
WOMEN'S & MISSES' VINYL	TAIWAN	131.8	82.8	1.59
WOMEN'S & MISSES' LEATHER	SPAIN	115.6	15.7	7.33
MEN'S & BOYS' LEATHER	KOREAN REPUBLIC	113.9	27.7	4.11
WOMEN'S & MISSES' LEATHER	BRAZIL	106.6	21.8	4.88
MEN'S & BOYS' LEATHER	ITALY	78.5	8.3	9.37
MEN'S & BOYS' LEATHER	SPAIN	74.1	11.7	6.29
TOTAL WOMEN'S & MISSES	——	534.4	147.1	3.63
TOTAL MEN'S & BOYS'	——	266.5	47.7	5.59
TOTAL LEATHER	——	669.1	112.0	5.97
TOTAL VINYL	——	131.8	82.8	1.59
TOTAL OF THIS TABLE ACCOUNTS FOR 53% OF ALL FOOTWEAR IMPORTED (PAIRS) BY U.S. AND 55% OF IMPORTED VALUE.				

USA (43.1%), France (12.1%), United Kingdom (7.3%) and other nations [3].

Four other countries, in addition to Italy, produced very significant amounts of footwear for the U.S. market at a price below that of domestic production. Table 1 furnishes information on several categories of footwear with import value above $50 million per year. Italian leather women's shoes lead imports from Taiwan, Spain, Korea and Brazil. These seven categories of footwear imported into the U.S. account for 53% of all footwear imported (value). Imported leather footwear exceeds 5 times the imported synthetic footwear in dollar value. In quantity of imports (pairs), leather footwear imports are 1.4 times higher than synthetic footwear.

Women's imports from these five countries are 2 times higher than men's imports (in value) and, on the whole, in terms of quantity, the women's imports are 3 times higher than the men's. The ratio of women's / men's pairs of shoes produced domestically was 1.3 in 1977. Thus imports have penetrated the women's sector more extensively. Indeed in the New England area more women's footwear plants have closed than men's.

1.1.2 <u>Strength of the Italian Footwear Industry</u>

Without doubt Italy has a most successful footwear manufacturing industry and a relatively high standard of living among all the nations exporting footwear to the U.S. On the basis of our visits to several U.S. retailers, to three Italian shoe manufacturers, and to the Italian shoe manufacturing association, we conclude that the following features account for the uniqueness of the Italian footwear product:

1. High quality leather is used throughout. Italians buy most of their hides and skins from EEC member countries (see Table 2). These hides and skins are of better quality than U.S. rawhides because European cattle is raised on small farms with fences which do not harm the hides. Almost all

TABLE 2 DOMESTIC SUPPLY, IMPORT AND EXPORT OF RAWHIDES OF 4 EEC COUNTRIES YEAR 1975 (FROM REF. 4)

DOMESTIC SUPPLIES (NUMBER OF HIDES OR SKINS)			
	CATTLE HIDES	CALFSKINS	GOAT AND KIDSKINS
ITALY	2,878,000	928,000	283,000
FRANCE	4,311,000	3,779,000	505,000
GERMAN FEDERAL REPUBLIC	4,487,000	747,000	4,000
UNITED KINGDOM	4,829,000	530,000	——
IMPORTS (IN TONS)			
	CATTLE HIDES	CALFSKINS	GOAT AND KIDSKINS
ITALY	207,891	40,126	12,697
FRANCE	44,121	2,029	2,297
GERMAN FEDERAL REPUBLIC	43,167	7,769	2,054
UNITED KINGDOM	32,139	1,239	704
EXPORTS (IN TONS)			
	CATTLE HIDES	CALFSKINS	GOAT AND KIDSKINS
ITALY	4,256	3,418	35
FRANCE	100,557	24,139	1,339
GERMAN FEDERAL REPUBLIC	79,357	5,604	94
UNITED KINGDOM	67,854	2,300	——

cattle is fed with grass and hay. Hormone treatments are forbidden by law. Cattle are not branded. This yields better quality rawhides and skins. Goat and kid skins are also used extensively (see Table 2). Only a small percentage of hides from the U.S. is imported by Italy (see Table 3).

Although contradicted by retailers, there does not seem to be a technonological advantage in Italian tanning and finishing procedures compared to those in the U.S. This can be attributed to the fact that chemical treatment technology is obtainable from major international chemical manufacturers.

2. High quality stitching and finishing is done by motivated and skilled workers who are mostly paid on hourly rates. In general, in villages where footwear is made, no other industries compete for the labor force. This leads to very low turn-over rates and to dedication of workers to their employment.

3. Footwear styles closely follow clothing fashion trends and large numbers of different styles are produced on an industry-wide basis. This is due in part to the fact that most Italian footwear manufacturing companies are small, with an average of about 16 workers [5]. This provides an enormous flexibility and design adaptation. Each small company also has its own designers. It is not surprising therefore, to observe so many different designs being produced by the Italian manufacturers.

4. The excellent reputation of Italian designers throughout the world makes Italian fashion-dependent products more competitive.

1.1.3 Italy Compared with other Footwear Exporting Countries

Even though its standard of living is below that of the U.S.A., Italy does not seem to benefit significantly from lower labor rates in the footwear industry. As indicated in Table 4, the average earnings of a pull toe lasting operator are only 20% lower in Italy than in the U.S.A. Transportation costs

TABLE 3 US MAJOR CATTLEHIDE AND CALFSKIN EXPORTS BY COUNTRY - 1975 (FROM REF. 2.)

NUMBER OF CATTLEHIDES		NUMBER OF CALFSKINS	
JAPAN	7,108,000	JAPAN	614,000
MEXICO	2,362,000	KOREAN REPUBLIC	340,000
KOREAN REPUBLIC	2,203,000	MEXICO	222,000
RUMANIA	1,226,000	ITALY	173,000
SPAIN	948,000	REMAINING	702,000
CZECHOSLOVAKIA	877,000	TOTAL	2,051,000
CANADA	805,000		
POLAND	787,000		
TAIWAN	744,000		
U.S.S.R	660,000		
ITALY	565,000		
REMAINING	2,984,000		
TOTAL	21,269,000		

TABLE 4 COSTS FOR PULL TOE LASTING OPERATORS (FROM REF. 7)

SELECTED COUNTRIES

1977 DATA

COUNTRY	AVERAGE HOURLY EARNINGS PULL TOE LASTING OPERATOR	ADDITIONAL FRINGE %	TOTAL
GERMAN FEDERAL REPUBLIC	$4.60	65%	$7.59
U. S. A.	4.20	30	5.46
FRANCE	3.30	55	5.11
ITALY	3.45	30	4.48
JAPAN	3.19	20	3.82
SPAIN	2.81	30	3.65
UNITED KINGDOM	2.65	19	3.15
BRAZIL	.73	86	1.35
INDIA	1.33	—	1.33
GREECE	1.09	8	1.19
TAIWAN	.66	15	.76
KOREAN REPUBLIC	.36	20	.43

and import duties on Italian footwear amount to approximately 25%, thus vitiating the wage advantage. The really low wage countries such as Spain, Brazil and particularly Taiwan and the Republic of Korea make definite use of very low cost labor to compete with the U.S. as well as with other high labor cost countries such as those in the European Economical Community (German Federal Republic, Italy, France, United Kingdom, The Netherlands, Belgium, Denmark, Ireland and Luxembourg).

The Italian footwear industry has clearly opted for high quality and fashion footwear made from excellent materials. This choice reduces the percentage of labor cost in the final price of the product. In short, Italian footwear manufacturers make no effort to compete with cheap footwear produced in high volume in low wage countries. However, it is doubtful whether this strategy (as discussed by the Italian footwear manufacturing association) will be sufficient to keep the Italian industry competitive in the years ahead as low wage countries (e.g. Republic of Korea) try to increase the quality and value of their footwear production so as to overcome the U.S. import quota which is based on quantity alone. This trend is already indicated in Tables 1 and 3; Korean imports are for the most part leather footwear which command high prices.

The Taiwanese footwear industry can be severely affected by import quotas based on quantities because of the extremely low unit value of their goods. Under 100% free trade conditions, footwear with a relative high labor content, e.g., vinyl women's footwear, is the most competitive footwear that can be produced by a low wage country.

1.1.4 Economic Policies of U.S. Corporations

Interviews with retailers and U.S. footwear manufacturers indicated that most large U.S. footwear manufacturing corporations are major importers of foreign-made footwear. These firms purchase footwear from foreign manufacturers and establish new plants in low labor rate countries. It indicates that large amounts of U.S. captial is invested in U.S.-owned foreign companies rather than in R&D for higher productivity here in the United States. This situation is not likely to change until there is a clear indication that R&D can be justified in terms of return on investments.

During the visits to different U.S. footwear manufacturing plants, tanneries and a last manufacturing plant it was noticed that most of the modern machinery is imported from Europe by U.S. corporations. It indicates that the machinery manufacturers in the U.S. are not active in the development and manufacture of new footwear machinery. The lack of innovation in the footwear industry is partly attributable to lack of vigorous R&D activities on the part of machinery manufacturers. Insufficient data have been collected by the investigators on this topic. It certainly is worthwhile to study this issue thoroughly.

1.1.5 Conclusions

The major issues created by international competition can be summarized as follows:

*Domestic production of non-rubber footwear has decreased by 40% in 10 years. This trend is not expected to change unless major remedial action is undertaken.

*Imports from high labor rate countries penetrate the U.S. high quality fashion footwear market. Excellent raw material, workmanship and designs are key elements in successful penetration of the high quality footwear market.

*Low labor rate countries supply large quantities of cheap and medium range quality footwear to the U.S.

*A viable U.S. footwear industry has to meet the international competition by concentrating on the production of good quality, fashionable footwear at low cost.

*Without the introduction of new technologies for the footwear industry there is little hope for the U.S. footwear industry on a long term basis.

FIGURE 5 CATTLEHIDE PRICES (FROM REF. 2)

1.2 Techno-Economical Issues

Technical and economical factors have to be taken into account in assessing the footwear industry. Important elements are the properties and cost of raw materials, the cost factors of footwear manufacturing processes and the fashion trend in footwear. Each of these issues is discussed briefly to arrive at a set of criteria for evaluating footwear technologies.

1.2.1 Leather as the Most Important Raw Material

The properties of genuine leather and man-made materials have to be taken into consideration in evaluating new manufacturing technologies. Genuine leather is furnished in irregular shapes with such flaws in the surface as scars, brand marks, insect bites, etc. Man-made materials are very regular in shape and are free of obvious defects, enabling a significant increase in manufacturing productivity. Mostly for comfort reasons, man-made materials have not been able to substitute genuine leather. The vapor penetration rate through the best man-made materials on the market (poromerics) is three to seven times lower than that of leather [8]. Thus, footwear made from these materials gives a wet uncomfortable feeling after only a few hours of wearing. Sandals or closed shoes worn only during very short periods of time do not necessarily give this uncomfortable feeling; so the use of man-mades is common in this sector of the industry.

Rawhides will always be available as a by-product from the meat industry. Very large cost variations in rawhides occur because the slaughter frequency does not match the demands for raw materials by the tanneries and the footwear industry. As an example, Figure 5 represents cattlehide prices showing fluctuations larger than 100% from one year to another. In leather footwear, the cost of the rawhide or skin is of the order of 20% to 25% of the gross selling price. As a result, doubling the rawhide cost could result in 20% to25% increase in footwear cost.

TABLE 5 BREAKDOWN OF FOOTWEAR MANUFACTURING COSTS

WOMEN'S DRESS SHOES		MEN'S WELTED DRESS SHOES	NUMBER OF OPERATIONS
MATERIALS			
UPPERS	10 %	32.6%	
LINING	2 %	5.4%	
SOLES & HEELS	12 %	16 %	
REMAINING	9 %		
TOTAL	33 %	54 %	
DIRECT LABOR & MACHINE COST			
CUTTING ROOM	4.2%	2.5%	2 - 4
FITTING ROOM	21.6%	8.5%	25 - 45
STOCKFITTING ROOM	2.2%	1.9%	2 - 14
LASTING ROOM	5.2%	2.8%	3 - 8
MAKING ROOM	2.2%	6.2%	10 - 27
FINISHING ROOM	5.6%	3.1%	5 - 15
TOTAL	41 %	25 %	
OVERHEAD & PROFIT	26 %	21 %	

Similarly, changes in demand for footwear manufactured from leather can influence the rawhide price significantly because of the inflexibility in rawhide supplies.

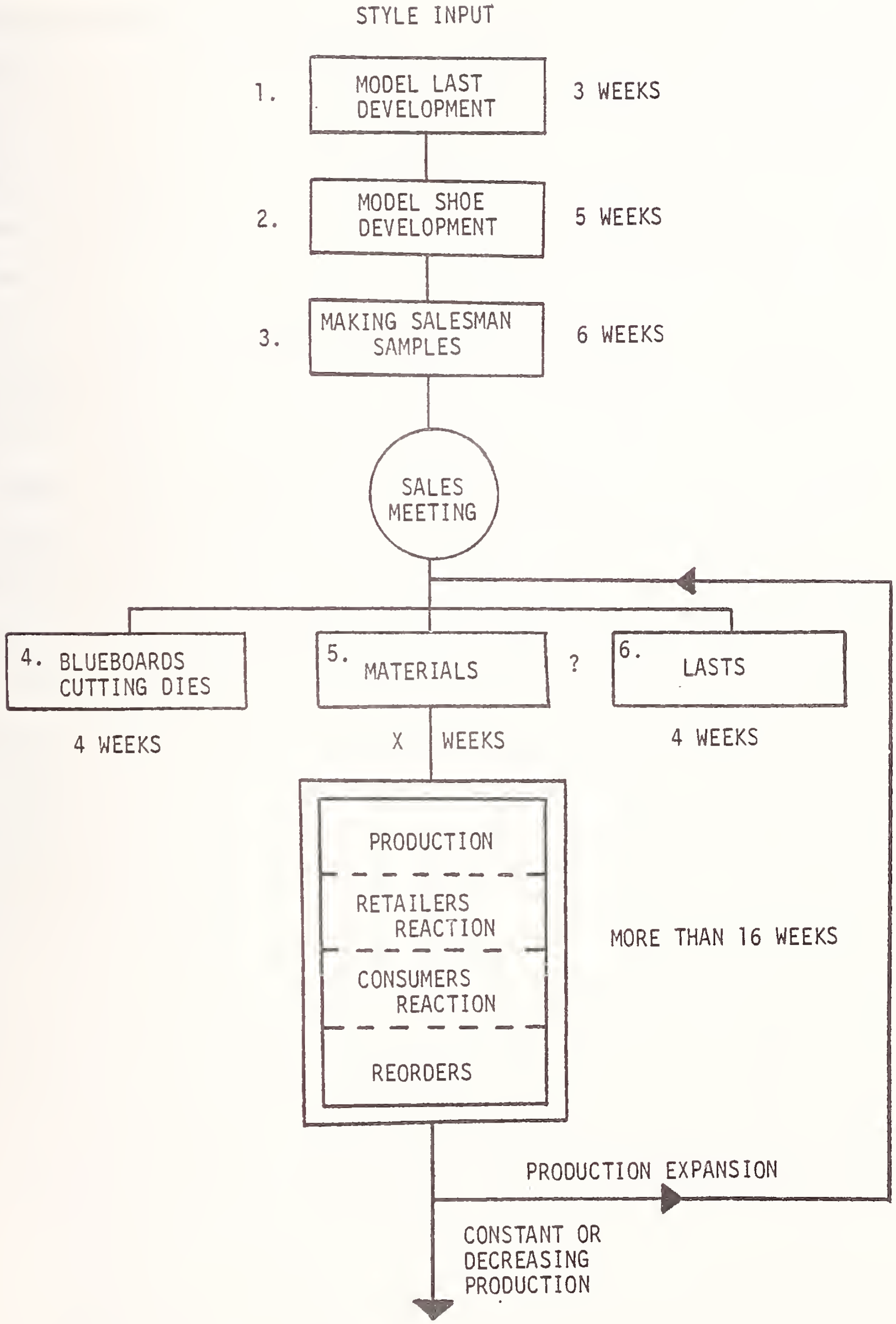
1.2.2 Micro-Economy of Footwear Manufacturing

Evaluation of new footwear manufacturing techniques must also be based on the cost structure of U.S. footwear manufacturing plants. A cost breakdown for women's dress shoes and men's welted dress shoes is given in Table 5. This table is based on data collected from shoe manufacturing plants. The more detailed labor cost breakdown into the different operations is partly based on data reported by other investigators [9,10]. Table 5 can be used to calculate what impact an improvement of an operation, materials utilization or overhead efficiency can have on the total cost of the product. In every evaluation of costs one should take into consideration that a large number of operations is involved in every manufacturing division, e.g., if the cost of the fitting room is 21.6% of the total manufacturing cost, the cost per operation will roughly be .72% when 30 operations are executed in the fitting room. As a result, a doubling of the productivity of one fitting room operation will roughly reduce the total manufacturing cost by .36%.

1.2.3 Fashion Trends

Almost all footwear styles have to change according to fashion trends, some styles have a very short life time (e.g. dress footwear), others are produced for many years (e.g.workshoes). The largest market is in the short lifetime styles. Therefore, footwear manufacturing technologies have to be adaptive for product changes. Starting costs for new styles constitute only a small fraction of the total manufacturing cost, but the loss in profit due to slow response to demand might be very significant. Therefore, the adaptability (flexibility) of manufacturing technologies has to be evaluated in

FIGURE 6 TIME SCHEDULE FOR PREPARATION AND SUPPLY OF NEW STYLES



light of growing consciousness for style by consumers. The time it takes to prepare and supply new styles can be subdivided as in Figure 6. These data were collected from different companies. Today cutting dies and lasts can be delivered within the times shown in the chart, since an overcapacity in the New England area exists due to the significant reduction in footwear production.

For fashion footwear it is extremely important to prepare production for styles that are going to be successful. Stylists, salesmen and managers have to predict what styles will catch on during the seasons ahead. Once dies, materials and lasts are bought, investments have been made before real sales response from consumers is obtained. Styling and tooling expenses for unsuccessful products have to be recovered by profits on successful styles. Therefore, very good styling departments are necessary for every company in fashion footwear. To meet the demand for successful items in full season the reaction time should be as short as possible. When a successful style has been developed in house, production can be expanded only after ordering additional materials and lasts. This could delay the expansion of the production capacity by more than 4 weeks (Fig. 6). However, when a company does not rely on in house stylists and prefers to copy what is successful during a season, faster development and production of tools and materials are neccessary. The production schedule has to include the manufacture of a model last, grading for other sizes, etc. Copying requires less in house styling but appropriate technologies for short reaction times must be used.

For direct injection molding of soles, style responsiveness is seriously limited by the time it takes to obtain the molds and by their very high cost, necessitating high volume production. In mold making the U.S. is seriously handicapped by a lack of skilled die and mold makers and by labor intensive die making technology. Shortages of U.S. die makers cause a serious problem for several other industries also. Some companies solve these problems by importing dies. Better solutions should be found.

1.3 The Evaluation Criteria

Based on the different constraints imposed upon the industry be international competition and by other technical and economical factors one can formulate criteria for evaluating existing or new technologies for the U.S. footwear manufacturing industry. A series of five criteria are formulated as follows:

I. Effect of the technology under consideration on cost of U.S. non-rubber footwear products.

II. Effect of the technology on style adaptation time (reaction time).

III. Effect of the technology on the final products' materials and assembly quality.

IV. Effect of the technology on in house style perception and style inventiveness.

V. Time lag anticipated between the decision to implement the technology and the time when the effect on the U.S. market is evident.

Each of these criteria has been used in evaluating the technologies presented in this report. Those technologies which can be implemented from a purely technical point of view but which rate poorly by one or more of the evaluation criteria, will be unsuccessful.

2. Technologies for a Viable U.S. Footwear Industry

For the U.S. footwear industry to survive and grow, a better application of existing technologies and continuing advances in manufacturing and management techniques must compensate for the higher labor rate. A short term technological goal of the U.S. footwear industry should be a rapid technology transfer from other fields of science and engineering which will enhance their competitiveness over the foreign manufacturers. Coupled with the short term goal, long range plans for continuing technological advances must be initiated and implemented at the earliest possible date in order to provide the necessary lead time. Realistic long term R&D goals should also yield short term technological advantages for the U.S. industry.

2.1 Methods for Improving Competitiveness on a Short Term Basis

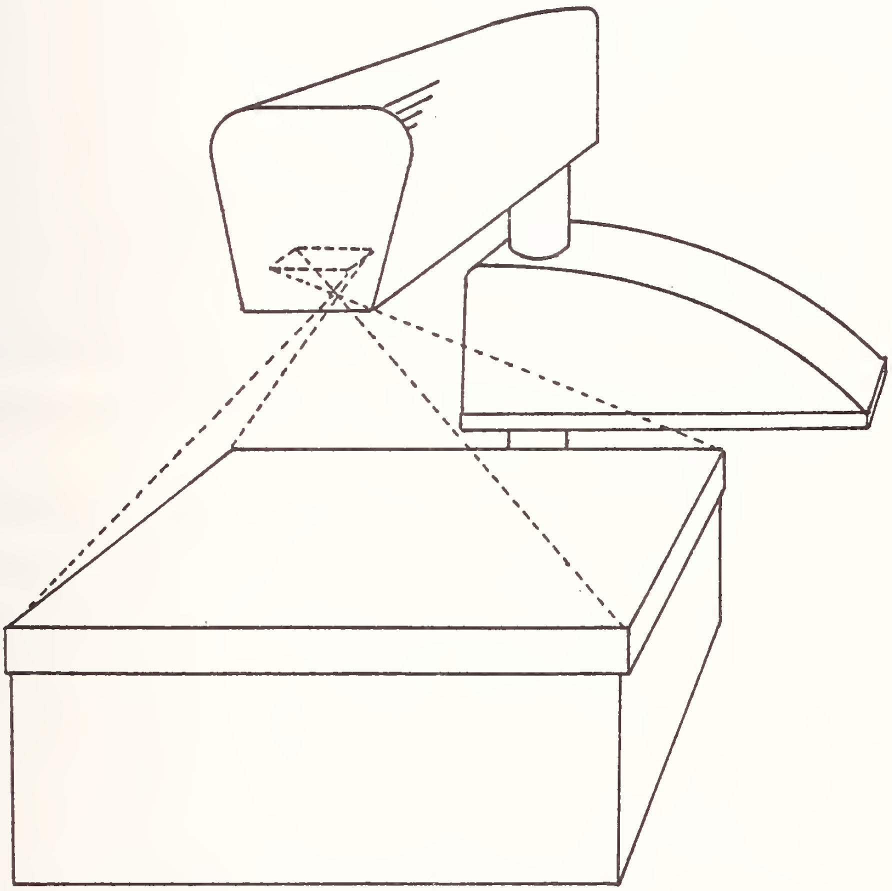
The anticipated time lag between the decision to implement a new technology and its effect on the market (evaluation criterion V) has been used to group technologies into two categories: short term technologies and long term technologies. Technologies which can be put into operation within a two-year period are described in this section. In discussing the short term needs, manufacturing methods were ordered according to anticipated reduction of final product cost (criterion I) and probable decrease in style adaptation time (criterion II). Training and continuing education are discussed in this section because of the acute shortage of young workers, especially in the New England area.

2.1.1 Materials Utilization

Product cost can be reduced most significantly by better utilization of materials. As shown in Table 5 of Section 1.2.2, materials cost accounts for 33% of the cost of ladies' cemented shoes and 54% of men's welted shoes.

The largest materials savings might come from a reduction in waste of upper leather. Therefore, we present ideas for improving cutting equipment.

FIG. 7 - CUTTING TABLE EQUIPPED WITH PATTERN PROJECTION SYSTEM



Most cutters work with sides or skins which are 3 to 5 times larger than the surface of the cutting machine. As a result, observation of flaws and grain characteristics of the complete side in one glance is very difficult or impossible. Planning of cutting jobs for the complete side could be done better if the table surface is enlarged to accommodate the entire piece of leather. A table surface of approximately 96" by 36" would be required for large sides. The machine would have to be equipped with a traveling head for reaching every location on the table.

The increase in cutting table dimensions would become even more beneficial if the cutter could be equipped for nesting patterns properly before cutting is started. This could be done, for example, by designing a system that can project pre-nested patterns on the leather as shown schematically in Fig. 7. Before cutting is started, the operator shifts the pattern around until a maximum number of useful parts can be obtained from the side. This method of operation permits a very quick change of the pattern mix whenever necessary. Optimum nesting could be achieved by shaking a set of patterns to a maximum packing density.

When optimal nesting of patterns is determined, cutting of the parts becomes an easy task without requiring additional judgement from the cutter. Furthermore, it enables a simultaneous cutting of several parts by placing several dies at the same time on the leather. The cutting force could be applied locally by rolling a large preloaded cylinder over the dies (Fig. 8). A leading and a following cylinder would be necessary to prevent dies from tilting. Dies which can stand the high bending stresses from the roller and which have a high flexibility for concentrating the cutting force locally, have to be designed.

A leather pattern can be cut with much lower total cutting force when

FIG. 8 - PRINCIPLE OF SIMULTANEOUS DIE CUTTING

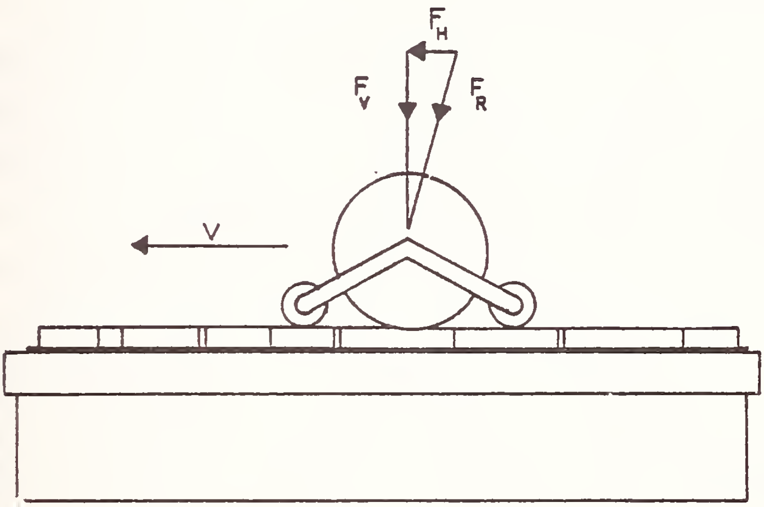
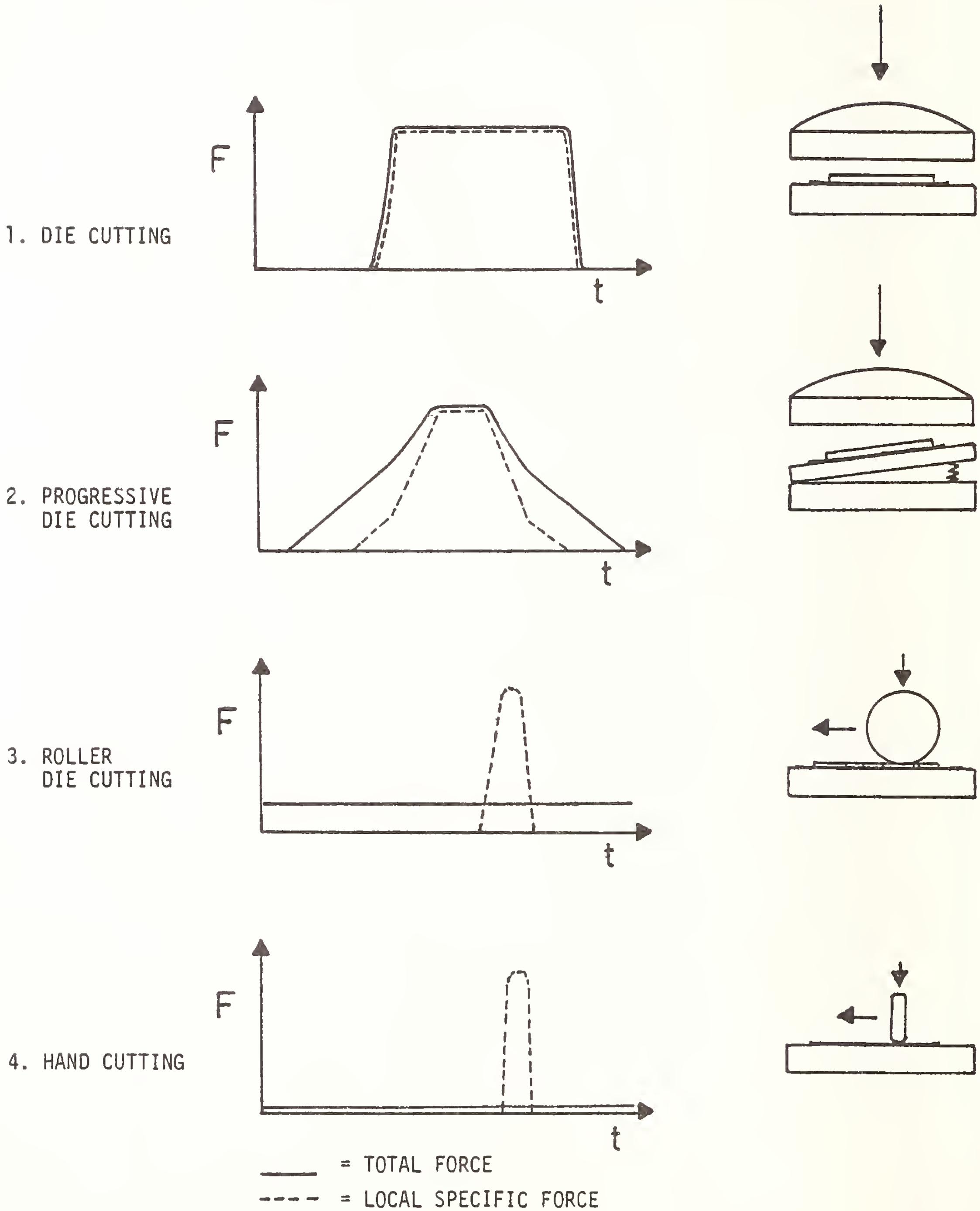


FIG. 9 - TOTAL FORCE AND LOCAL SPECIFIC CUTTING FORCE FOR FOUR DIFFERENT CUTTING SET-UPS



the force is applied simultaneously over the total die circumference. The total cutting force and local specific cutting force as a function of time for four different setups are shown in Fig. 9. It is remarkable to note that the current die cutting of leather requires 15 to 30 tons of total force, whereas manual cutting 1000 times less force. The high force in die cutting has been a serious constraint for changing the design of the worktable and cutting head configuration.

Cost savings from better upper leather utilization can be very significant. For example, about 90 $ft.^2$ of upper leather which costs $1.00 per $ft.^2$ is normally cut in an hour. Annual savings would amount to $9000 per cutter from a 5% materials saving. This might pay back proposed equipment within one year.

2.1.2 Testing of Materials

Loss of productivity due to bad materials in manufacturing processes can be avoided by testing to see whether materials meet normal standards. This applies to leather, threads, cements, etc. Simple test procedures could be designed. Especially before materials undergo labor intensive or critical operations, quality control tests should be performed; e.g., test of the stretchability of upper leather before it enters the fitting room and check of moisture content before lasting. Gross savings from such tests would be approximately 0.5% of the total manufacturing cost in a factory where 1% of the shoes show leather cracks after lasting.

Another example of an appropriate test would be to check the anisotropic properties of leather relative to the major directions of cut of upper parts. Indeed, a part cut in the wrong direction can be processed through the plant and will show up in the finished product. Only one fast test would be required to avoid the loss of added value in the subsequent operations. This information can be used to upgrade the skill of the operator by letting him know whenever he cuts bad parts.

Simple testing equipment could be designed and integrated into other operations. In general, the cost of testing has to be minimized by innovative test design.

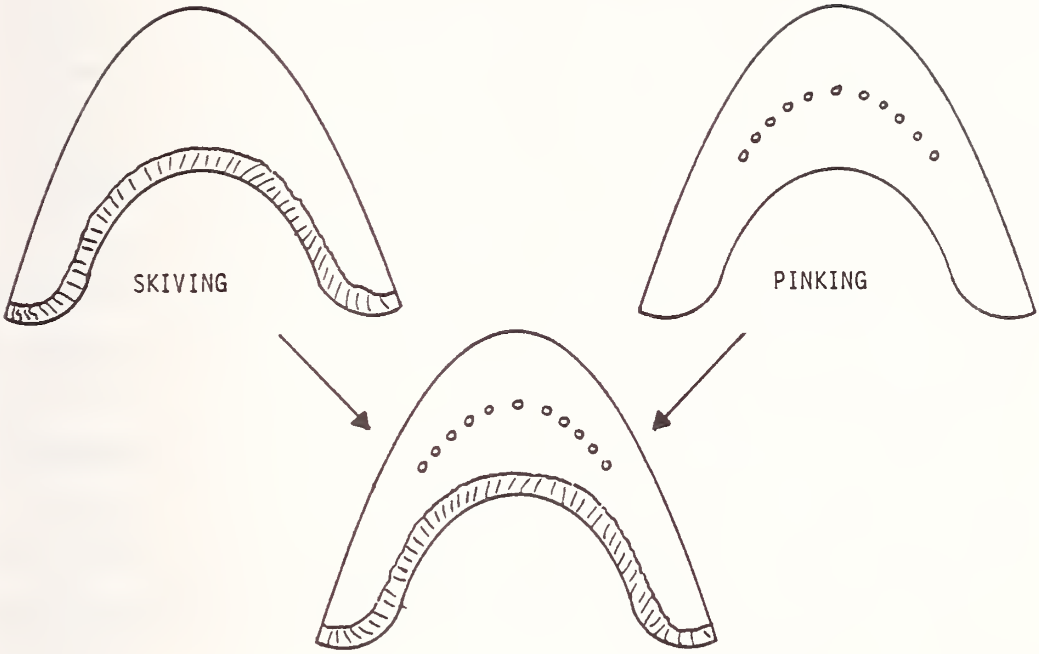
Adaptation time for new styles might be reduced by materials testing; e.g., a standard stitching test with measurement of dynamic thread tensions and static needle penetration and retraction forces could be used to evaluate new threads and materials objectively. This would be excellent for classifying threads and materials, identifying anticipated manufacturing problems and introducing measures to avoid problems (e.g., selection of best type of needle for a material and thread combination). A newly introduced style would flow more fluently through the plant during the transition period.

Finally, product quality can be significantly increased by testing materials and subassemblies. In the long run this will pay off in terms of a reputation for good quality.

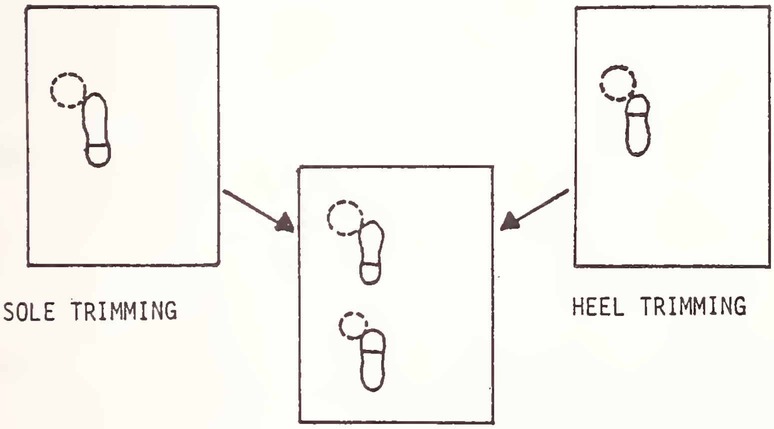
2.1.3 Reduction of Manufacturing Systems' Information Content

Information content is the amount of different dimensions, tolerances and other descriptions necessary to define the process or product completely and exactly. A relation seems to exist between the amount of information required for execution of a series of sequential manufacturing processes and manufacturing productivity. Reducing information content by combining processes is permitted as long as the functional requirements of the new process or its product can be satisfied independently [11]. In shoe manufacturing many small operations may be combined; e.g., template skiving and pinking are two separate operations which might be combined into one operation by designing a template

FIG. 10 - COMBINATION OF OPERATIONS



A. SKIVING AND PINKING



B. SOLE AND HEEL TRIMMING

which perforates and skives the leather simultaneously. (Fig. 10A). Systems analyses of footwear manufacturing plants are necessary to identify the opportunities for productivity increase. Every time a workpiece is laid on a rack information about the characteristics of the product and its exact position are lost. This information generally has to be restored for the next operation. When one operator can execute two operations on a component in one workstation, the amount of information is reduced and productivity should increase, e.g., combining the equipment for sole trimming and heel trimming in one machine gives one operator the possibility to perform these two operations sequentially. (Fig. 10B).

The following two axioms can be used to judge whether the above examples may increase productivity [12]:

1. Decisions which reduce the information required to describe either the product or its processing entail less risk and higher probability of success. (Minimization of information content)

2. A manufacturing system should contain just sufficient degrees of design freedom to satisfy the independence of the functional requirements. If there are more than enough degrees of freedom, then aspects of the design should be integrated, and if there are too few, the design can be completed only by additions, e.g., the combined skiving and pinking machine should yield the same flexibility for changing edges and perforations on the part as the separate operations do. If the skiving width is changed the dimensions of the pinked holes should remain the same and vice versa.

The above axioms and a series of other axioms for helping to make decisions in the conceptual stage of product and process design are under investigation in the Laboratory for Manufacturing and Productivity. [11,12]. Footwear manufacturing should benefit significantly from applying Manufacturing Axiomatics because functional requirements and constraints of the numerous different small operations involved can be defined very precisely. A more detailed discussion of the axiomatic approach for solving manufacturing problems is given in the publication added to this report as Appendix I.

2.1.4 Computer Assisted Management

Overhead costs can be reduced significantly, and more data can be generated to help managers in decision making by introducing a business computer in the factory. The availability of low cost computer equipment and services should be taken advantage of by U.S. footwear manufacturers to keep ahead of competition.

The actual cost reduction that can be achieved by decreasing the ratio of white collar to blue collar workers, has to be assessed for every plant separately. The experience of other industries with computers should provide useful guidelines.

An in-plant computer can assist managers by regularly supplying data on materials inventories, materials utilization, cost per manufacturing operation and materials flow through the plant. Profits should increase when the computer information is used effectively to maximize efficiency. For instance, one of the companies visited realized very significant cost savings in the cutting room by following the materials utilization of every cutter individually with a computer. Savings would be far less significant or ruled out entirely if additional administration had been required for collecting and preparing the data in an appropriate format.

Reaction time for re-orders can be decreased with the help of an in-house computer. For instance, women's footwear is manufactured in small numbers of pairs per style which results in an enormous variety of different components that have to be ordered and kept track of. This was mentioned as a major problem in the women's footwear sector. Printing of correct purchase orders and keeping inventories exact, should be possible with the help of a computer. Waiting times due to missing components can be avoided in this way. Gains in company profits because of decreased reaction time are hard to calculate but might be significant at times when demand for the product is high.

Finally, statistical data on sales can be computer generated for analysis and prediction of trends. Losses due to producing footwear styles which are no longer in demand can be avoided and risks due to preparing production for unsuccessful styles can be reduced. "Sleeping stocks" of out-of-fashion footwear will be recognized more readily and will be sold at sale prices before they lose their value entirely.

Computer systems for the footwear manufacturing industry should be set up for daily information inputs from the materials reception, warehouse, manufacturing and shipping departments. Data files should be updated at least on a daily basis because gains in reaction time are assessed in increments of days. Computer terminals should be available at a few appropriate locations in the plant for calling outputs from data files, but input might be centralized and controlled by processing input cards in the computer room.

2.1.5 <u>Training</u>

An acute lack of candidate footwear workers exists in the New England area, according to the managers interviewed by the investigators. Young workers only come to work in shoe plants until a job is found in better paying and growing industries. The very high turnover rate resulting from this (60-100% was mentioned) decreases productivity significantly because too many inexperienced operators are employed. A reluctance of management to spend training time on young workers aggravates this problem ("They will leave us anyway"). A past governmental effort to subsidize in plant training was poorly received by management because of the substantial additional administrative work required by the program. However, without properly skilled and trained employees, it will be difficult to introduce new technologies.

The idea of starting a footwear technology school as existed one time in Lynn, Massachusetts, was discussed with plant managers. Such a school is recognized as very helpful to the industry but an immediate financial incentive would have to be created before young candidate employees would attend the school.

In a training school, students' talents could be discovered and further developed. New employees who attend the school would be better prepared for the footwear industry. This should be reflected in higher hourly wages made by new workers on the piece rate system. Motivation to stay at the job would be increased, resulting in lower employee turn-over rates.

In other industries, many innovations come from dedicated workers with a good knowledge of their own specific task and the other manufacturing activities of the factory as well. Especially in footwear making, with its numerous small operations, innovations can be expected from workers who have an understanding of the whole production process and the product characteristics. New technologies might be created and more readily accepted by such workers. This synergistic effect of training and technology should lead to important productivity increases. Every new invention should be used to benefit employees and management in order to stimulate their further participation in developing innovative ideas.

A footwear design center should be included in a footwear technology school. The center should become a focal point for the development of design perception and inventiveness by maintaining close contacts with leading fashion schools in Europe. Design research into the optimal use of the hides tanned in the U.S. should be undertaken. During one of the factory visits, it was pointed out that very elegant women's footwear could be made with domestic leather by talented and well-trained designers. Unfortunately, it was in a tannery and not in a shoe factory, where this was called to the attention of the investigators.

This preliminary discussion of the advantages of a footwear technology school should be followed by a profound study of its social, economical and financial implications, especially the issue of location of the school headquarters and regional divisions. Such a study could be based on the history of the school in Lynn and on the experience of foreign (e.g. Germany) footwear technology schools.

Besides training of new employees, continuous updating of the technological knowledge of employees and managers is required. Audio-visual media might be of great help in spreading new manufacturing productivity ideas throughout the whole industry. Because a very large number of processes is involved in making footwear, a low cost method has to be used for communicating innovations. Video tape seems to be the most appropriate system for this purpose. The cost of hiring a crew, purchasing tape and videotaping subject matter that has been prepared beforehand amounts to approximately $200/hr for standard quality color videotape. The cost for acquisition of an inexpensive color playback system and a standard quality color TV would amount to $1500. A three-quarter inch cassette video-tape player with a 20-inch color monitor of high quality would cost $3000. The MIT Center for Advanced Engineering Study, which supplied the above information, has extensive experience in the development of audio-visuals for industry [13,14]. The Center reports an estimated audience of 6,000 to 12,000 yearly from a 700 tape library.

The success of an audio-visual footwear manufacturing technology program would depend largely on the willingness of companies to become teachers and pupils at the same time. We believe, therefore, that such a program can only be successful when it is integrated in a Cooperative Footwear Technology Program described in the third section of this report. Videotape systems seem to be more appropriate than reports for keeping information from a Cooperative Footwear Technology Program proprietary for the members of such a program.

In summary, craining of employees and designers will be very helpful to the industry while at the same time developing new technologies to keep the industry growing in dollar value output per employee. Doubling productivity in the U.S. by introduction of new technologies does not require layoff of workers. During 1977, domestic footwear production was only 50% of domestic consumption; thus, a footwear production increase could be absorbed by the U.S. market by its being more competitive than foreign made footwear.

2.2 Development of Technologies with Long Term Benefits

Productivity and reaction time have to be improved to insure a competitive U.S. footwear industry. Simultaneously, quality and styling (appearance and comfort) should not be ignored.

Computer Aided Design and Computer Aided Manufacturing have been under development during the last fifteen years mostly for the metalworking industries [15,16]. For the footwear industry CAD/CAM can minimize the reaction time for new footwear styles at reduced tooling cost. Therefore, research and development of new footwear oriented CAD/CAM systems should give the U.S. manufacturing plants lead time over foreign competitors. Several weeks can easily be lost in placing and shipping overseas orders.

The high U.S. labor rates have to be compensated for by increases in productivity. The inability to further automate assembly of flexible materials with existing equipment is a barrier to increases in output per man hour. Fundamental research in the assembly of flexible materials should be done. The footwear industry and also the apparel industry may benefit from innovations in this field. Finally, materials research is necessary for reducing the cost and improving the characteristics of U.S.-produced materials. Special treatments to obtain quality improvements of man-made materials having natural leather characteristics should be developed with footwear manufacturing in mind. Not only productivity but also reaction time may be improved with new materials. Innovations in the materials sector very often have a significant impact on productivity; e.g., polymer developments on the manufacturing of furniture, cars, etc. Methods for recycling leather and refitting of lasts must be investigated because important savings in cost may result.

These different research efforts are only preliminary proposals. Through close cooperation between research organizations, tanneries and footwear manufacturers, one should decide upon and execute such research projects (see Chapter 3 on cooperative research).

2.2.1 Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM)

Normally, more than 14 weeks are necessary for designing and making footwear samples, and another four weeks are required for obtaining dies and lasts (Fig. 6). Thus about 4 1/2 months of lead time is necessary before a factory can start production; it will take more than five months before retailing can start. Within this long period of time foreign competitors can easily prepare their own product in time for marketing. The U.S. footwear industry badly needs a reduction in lead time because U.S. fashions closely follow foreign styling trends. Shortening this lead time will certainly be possible with Computer Aided Design and Computer Aided Manufacturing.

Also, the cost of developing new footwear styles can be reduced by CAD/CAM. In the U.S., the cost of producing last models, correcting lasts, manufacturing trials, pattern making, grading, cutting die making, skiving, template manufacturing, last manufacturing, etc. can easily amount to $25,000 for one style. Most U.S. manufacturers limit the number of different styles and try to produce large quantities of the same style in order to reduce the relative cost of tooling. CAD/CAM systems can substantially reduce this cost by improving the efficiency and reducing the labor intensity of development and manufacture of tooling.

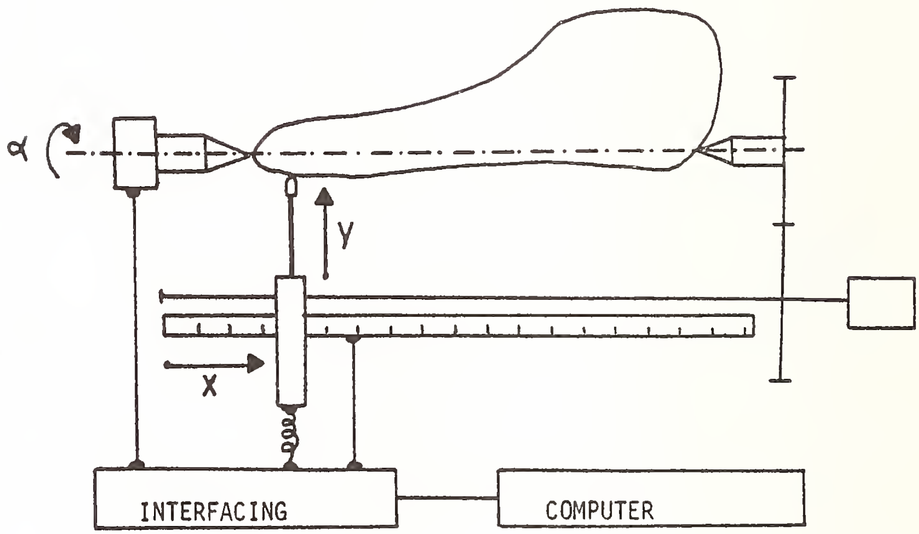
Finally, Computer Aided Manufacturing has already been proven to greatly increase productivity of decorative stitching. Computer controlled manufacturing systems will be very effective when fundamental research for assembly of flexible materials and research on new materials are executed simultaneously. The synergistic effect of computers, assembly methods, and materials innovations can have a most significant impact on manufacturing productivity. Some examples of CAD/CAM concepts follow, but more detailed analysis is necessary in order to determine which research should be started first and which sequential steps should be followed.

2.2.1.1 Input of Last Shapes and 3D Patterns into CAD Systems

The complexity of the shape of feet and thus last shapes has always been a major problem for automation in footwear manufacturing. Finding an efficient way of inputting, storing and retrieving last shapes is a challenging task. Success of CAD in footwear relies on how successful one is in last shape handling.

Model lasts are complex in shape and are manufactured mostly in hard woods with metal reinforced edges for good wear characteristics. Therefore, manufacturing of model lasts is difficult and time consuming. It may be much more productive to make last models from softer materials, to shape lasts from materials plastically deformable by hand or to cast models directly from the inside of existing shoes. In these three cases the model last itself would only serve as a three dimensional representation of the surface of the lasts to be manufactured. It could not be used directly to drive the

FIG. 11 - SCHEME FOR AUTOMATIC LAST SURFACE REGISTRATION



cutting tool in last turning machines.

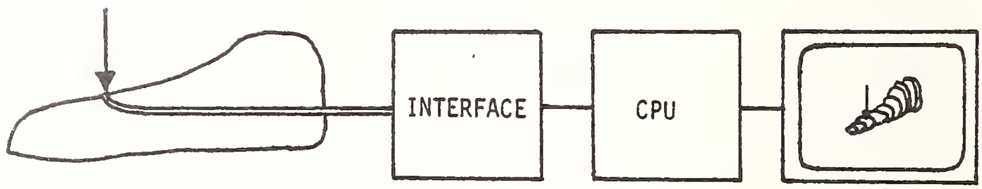
The surface of soft model lasts can be digitized by a surface registration system as represented in Fig. 11. A motor rotates the last while the electronic pick-up (inductive, optic, etc.) moves along the last at a longitudinal velocity dictated by the last rotational velocity. Angular position of the last and position of the pick up (last surface) are processed by the computer and stored in core memory or on magnetic tape or disc.

The amount of digitally stored information which is required for regeneration of the surface should be optimized. Storage of one point per mm (.040 inch) of the perimeter during a revolution would occupy approximately 300 memory locations (bytes). Over the whole last surface 90,000 bytes (300x300) would be necessary if a perimeter would be stored per mm on a longitudinal last axis of 300 mm (or 1 ft.) This would certainly be enough for obtaining an exact replication of the last.

Required computer storage capacity for lasts might be reduced by using Fourier descriptors. This mathematical technique makes use of a Fourier analysis of the parametric description of a closed curve; only a series of coefficients of the Fourier analysis is stored in the computer. [17,18]. The technique was successfully applied for storing and retrieving two dimensional shapes of workpieces. Previously published information dealing with this topic [19] is added as an appendix to this report. By using Fourier descriptors the amount of information per last cross section perimeter can be reduced from 300 points to approximately 30 for accurate reproduction of the shape. As a result, only 9,000 bytes would be necessary for the full 3D last shape. Computer storage is more economical using this technique.

Design of shoe patterns could be done in different ways once the last has been input to the computer. A convenient way would be to trace pattern

FIG. 12 - SCHEME FOR GENERATING PATTERNS WITH SENSITIVE LAST



lines on the soft last or to make a mock-up shoe around the soft last. The 3D pattern boundaries would be introduced into the computer by following them with the pick-up of the system represented in Fig. 11. The last rotation shaft and the lead screw from the pick-up would have to be decoupled. Only x and α coordinates of pattern boundaries have to be registered. Exact 3D shapes of the patterns can be calculated by the computer from the last's y values for x and α ;[$y=f(x, \alpha)$].

Direct generation of patterns on a screen would be possible if the designer obtains a good picture from the shoe. On a screen the last would be represented in perspective by drawing a certain number of the 300 perimeters stored in the computer memory. By calling a perimeter number and two angles (e.g. typed input) the operator could select where the pattern should intersect with that perimeter. A part of the perimeter can be represented in a different color selected by the operator. Repeating this operation a few times would produce a color picture in perspective of the patterns on the last. An interactive screen could be used for input of pattern information. Magnification of parts of the last would be necessary for obtaining enough accuracy in pointing at perimeters.

A third system proposed for generation of patterns makes use of electrical wires or optical fibres mounted in a last (Fig. 12). Activation of "sensitive points" (electric or optic) on the surface would generate computer information shown on the TV monitor in a pre-selected color. This could be a very fast way for inputting 3D pattern information.

2.2.1.2 Computer Aided Generation and Correction of Last Shapes

A CAD system loaded with standard last information can be built to enable generation of new lasts or correcting lasts in its memory. For instance, algorithms could be developed for adjusting lasts to different heel heights or toe shapes. In fact, after frequent use, the data file of the last generator may become so rich in information that no model lasts would have to be made anymore. Only when a style is copied one might want to replicate the inside shape of the shoe.

After making trial shoes, corrections on lasts can be made by inputting changes with the pick-up (Fig. 11) or by directly changing perimeter shapes on the active screen. Appropriate algorithms have to be developed for automatic adjustment of perimeters when a limited number of them have been changed. These algorithms smooth the surface after corrections were made.

2.2.1.3 CAM of Lasts

Post processed last information from a CAD system can be used for manufacturing lasts. Information stored on magnetic tape or on floppy disc can drive a stepping motor controlling the depth of cut of a last turning machine. This shape generation system would be much more compact than these used in existing machines. Therefore, productivity over existing last making machines could be increased by roughing and finishing the last using two cutters in one operation.

The major advantage of the CAM last making system would be the decrease in reaction time of the last manufacturer. Indeed, only a few minutes for copying the digital data is required to prepare additional machines for manufacturing more lasts simultaneously. The existing last making machines continuously require a hardwood model last to be traced to drive the depth of cut. These model lasts, as mentioned before, are very expensive and take a long time to make.

2.2.1.4 Computer Aided Pattern Grading

Information on 3-dimensional lasts and 3-dimensional patterns for shoes can be used for grading. The most difficult task is writing computer software for developing a 3-dimensional pattern into 2-dimensional pieces which will stretch within certain limits in lasting. Today the search for optimal 2-dimensional shapes is done by trial and error in lasting which is one of the reasons it takes two months to develop model shoes. The lasting operation itself depends largely on the material properties of the final product. Thus, the CAD system will have to take the properties of the materials into account for determining 2-dimensional shapes of patterns. Therefore, theoretical and experimental research is necessary to develop the computer algorithms.

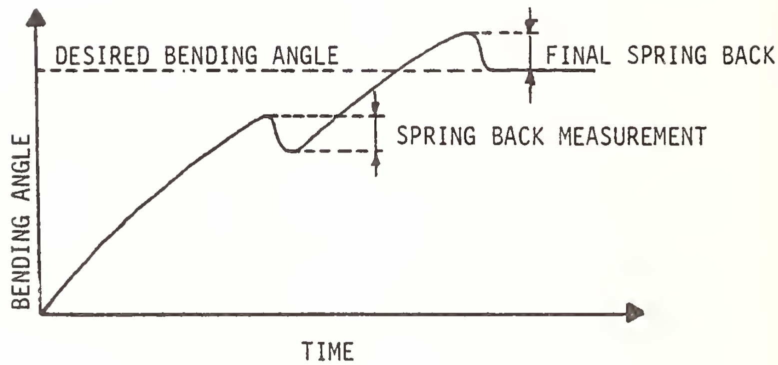
Grading of 2-dimensional patterns can be done with existing computer programs. No lasting problems are anticipated in proportionally graded patterns because stretching is the same for all sizes. However, when arithmetic grading is used, patterns have to be corrected for stretching according to sizes. A software package for all grading systems should be developed. Output from CAD grading systems can be in the form of drafted patterns or digital information on magnetic tape or floppy disc for driving CAM systems.

2.2.1.5 CAM of Cutting Dies

The largest cost in cutting dies relates to manual bending of steel band according to the requested form. Spring back of the steel band in bending requires frequent checking of angles. Also curves in bending are very difficult to achieve because of spring back. A completely different approach to this problem is necessary. Manufactured with existing technologies, a set of cutting dies can cost $5,000 to $10,000. The total time required for pattern and die making is two to four weeks depending upon the die maker's work load.

Within the Laboratory for Manufacturing and Productivity, a new principle for automatic metal forming is under development. The final spring back that can be expected is determined by forming in sequential steps and measuring the spring back in between steps. These measurements are used for calcu-

FIG. 13 - BASIC PRINCIPLE OF SEQUENTIAL BENDING



lation of the final position of the bending actuators such that the part, after spring back, will have the desired angle (Fig. 13). Based on this principle a computer assisted machine could be developed for bending cutting dies. Digital output from Computer Aided Grading would be used as input for the bender. Die cost and reaction time would be decreased when such machines are developed and manufactured economically.

2.2.1.6 Computer Controlled Cutting Systems

Digitized nested pattern information can be used to directly drive a cutting system with a laser or water jet cutting head. Such systems are under development but the major problem to be solved is the automation of leather flaw detection [20,21]. Further problems to be solved in these systems include focusing the laser on leather which is not perfectly flat and the high energy consumption of a water jet cutter. Both systems will be very promising once the above problems are solved. If fitting of patterns were computer optimized, taking flaws and raw material characteristics into account, major material savings can be made.

In order to make computer-driven cutting systems economical for small companies in the U.S., existing systems must be re-designed. If no technological solution can be found for tailoring a computer-driven cutting system to the smaller companies' needs, methods must be found for time-sharing of large systems. The cooperative footwear technology program, discussed in Chapter 3, can contribute to finding acceptable solutions to this problem.

2.2.1.7 CAM Systems for the Fitting Room

Numerically controlled stitching has been a major technological developemnt for the footwear industry during the past few years. In particular, the productivity of decorative stitching has been dramatically increased by N. C.

Efforts to develop systems for assembling parts have been partially successful. The flexibility of the materials is the major problem. Special pallets for holding materials together have to be used. This reduces the reaction time, fashion adaptability, and productivity. Fundamental research for reducing the necessity of pallets has to be undertaken as discussed in the next section.

If CAD systems are used for pattern design and grading, digital output can be used to manufacture pallets for numerically controlled stitchers. NC milling machines can make the slots in the pallets if post-processors for the milling machines were made.

2.2.1.8 Implementation of CAD/CAM in the Footwear Industry

The most significant anticipated advantages of CAD/CAM systems in the footwear industry are a decrease in reaction time and an increase in style adaptability. CAD/CAM is expected to reduce the design and tooling time from several months to a few weeks if equipment is interfaced properly. In fact, systems for CAD and CAM should be introduced simultaneously; e.g., the advantage from a CAD system for lasts and patterns is maximized only when CAM systems for last making, die making, etc., are also available.

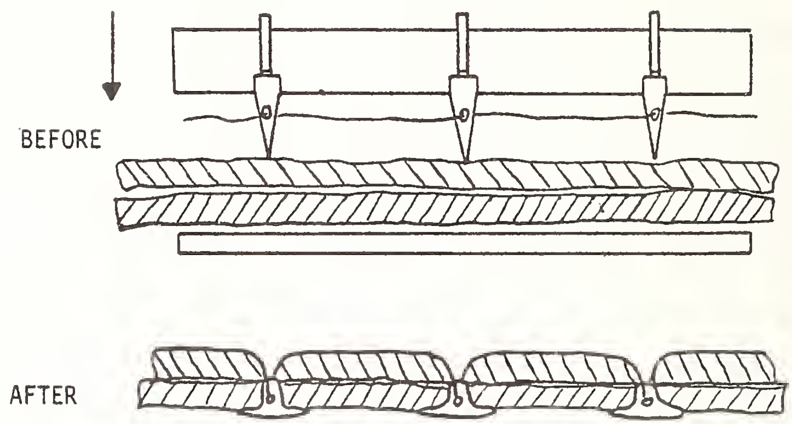
Until now CAD/CAM systems for footwear have not been developed to a large extent. This might be due to the large investments in R&D required and also to the small market for such equipment. Computer companies concentrate on developing equipment for larger and more profitable industries. The final cost of equipment, if cost for its development can be covered by a cooperative research program, is expected to be low, because prices of computers and peripheral equipment have dropped considerably during the last ten years. Profits made by faster response to markets and by a greater variation in styles are expected to be high.

2.2.2 New Assembly Techniques

Undoubtedly, stitching is the most labor intensive assembly technique in footwear manufacturing. It accounts for 75% of the operations in the fitting room and between 6% and 16% of the total manufacturing cost. Therefore, it is certainly worthwhile to investigate opportunities for increasing the productivity of stitching operations. Improvements made in this field can be very beneficial for the apparel industry at the same time.

The functional requirements of stitches are appearance and strength. Lock-stitches and chainstitches fulfill these functional requirements with great satisfaction for the consumer. The stitching operation itself is not so satisfactory to the manufacturer because it is very difficult to automate. This is mainly because of the flexibility of the materials and the relatively high forces involved in stitching. Leather has the highest ratio of puncture resistance to stiffness [22]. If not properly supported, it is greatly deflected by the needle penetration force and the thread tensioning force. Deflections of the material during a stitch disturb the next stitch. Therefore, materials have to be held tight between the material support and a clamping foot. As a consequence, smooth curves in the stitching path require manual guidance of the flexible material between support and clamp, and for sharp turns, the clamp has to be lifted. In N.C. stitching, materials have to be clamped in the pallets as close as possible to the stitching seam. If the deflections or forces could be reduced while still meeting the functional requirements of the stitches, the productivity of N.C. stitching would be increased. Several systems for decreasing deflection of flexible materials in stitching should be investigated. For example, the needle penetration force could be reduced by drilling a small hole with a laser before the needle brings the thread through. Forces in laser drilling are negligible. When the hole is pre-drilled one could think of blowing the thread through the hole

FIG. 14 - CONCEPT OF RIVET STITCHING



which would make the needle unnecessary and avoid all problems associated with reciprocating movements of a needle. Thread locking could be done without large material deflection by pulling in the plane of the flexible material instead of perpendicular to that plane.

Antoher example of new concepts in assembling techniques for the fitting room is represented in Fig. 14. A combination of thread and rivets is used for holding two parts together. The rivets hang over the thread and are pushed through the material and pressed against a plate where the point is flattened. This operation can be done in one stroke or by sequentially penetrating one rivet at a time. No needle reciprocation or locking thread are required. Productivity of this operation may be an order of magnitude higher because of ease of automation.

Finally, a combination could be made of stitching and another assembly method. A temporary or permanent bond would hold parts together for ease of stitching. Control of the stitching operation would be much easier.

The examples above show that different concepts can be investigated to find solutions for the inconveniences, which for conventional stitching retard productivity increases. If stitching did not require the high penetration and locking forces or if the locking thread could be eliminated, stitching would be more easily automated. It would be possible to use small clamping wheels controlled by a computer to steer the flexible materials under the assembly head. The material edge or a traced line could be followed exactly be automatic systems. CAM in the fitting room seems to be only possible when sufficient progress in methods for assembly of flexible materials has been made.

2.2.3 Materials Research

Although large amounts of money have been invested in man-made leather research by important companies without great success, it still remains very important for the U.S. to make progress in materials. Especially because the U.S. has a yearly supply of approximately 40 million rawhides, of which about 50% are exported, research for making better use of this vast resource should be executed.

2.2.3.1 Automatic Detection and Correction of Flaws in Leather

A laser scanning system for flaw detection is under development for automatic laser cutting equipment [20]. The effectiveness of the cutting system will depend mostly upon the effectiveness of the flaw detection system. Concepts for detection of flaws in leather may be based upon ultrasonic, optic, and electric principles.

When flaws are detected automatically, some of them might be corrected by adding material, pressing, embossing, etc. The technical possibilities and the economics of flaw correction have to be investigated. Flaw corrected leather might be beneficial for productivity increases in footwear manufacturing and might lead to important savings in raw materials consumption.

Finally, all research into systems to prevent flaws in rawhides are very beneficial for the U.S. leather and footwear industry; e.g. research is done for replacing cattle brand marks by passive electronic recognition systems implanted under the neck hide. This saves around 1 $ft.^2$ of leather per animal which could lead to a 1% reduction of the U.S. manufacturing cost of leather footwear.

2.2.3.2 Recycling of Leather

Leather is a valuable material because of its strength, flexibility and its unique water absorption characteristics. Research should be undertaken to find valuable usage for leather waste; e.g., leather fibres mixed with small amounts of polymers and cured afterward might yield sheets of recycled leather with absorption properties almost as good as new leather. It may be a good sole material. Cost savings for the footwear industry would be significant if the price of scrap were to go up after the discovery of valuable applications for recycled leather and development of economical recycling methods.

2.2.3.3 New Technologies for Tanneries

During the visits to tanneries it was noticed that several opportunities for automation exist. The value added in the tannery represents 50% of the leather cost, and thus in many footwear industries 25% of the final cost of the product. This means that productivity increase in tanning is especially desirable for the footwear industry. Several operations in the tanneries are very labor intensive and could be automated if proper research for new machinery were done, e.g., every hide is tacked on a board, "pasted" on a board, or clamped on a frame for drying. These operations could be automated if suitable grippers and electronic detection equipment were developed.

A significant reduction in reaction time and an increase in flexibility in ordering materials would be obtained if dyeing of leather could become the last operation in the tannery. This would allow last minute leather color decisions, resulting in a shorter lead time for the footwear manufacturer. Reaction time for re-orders of footwear would also be reduced to a minimum. Tanneries would have to store undyed materials.

A cooperative Footwear Technology Program (see Section 3), should include tanneries also. Some of the research in materials will only be possible through an involvement of tanneries in the program. U.S. tanneries supply approximately 63% of their leather to footwear manufacturers [2]. Therefore, they can be considered as a part of the footwear manufacturing industry.

2.2.3.4 Refitting of Lasts

Old lasts can be refitted for new footwear styles by adding and removing material where needed. A system consisting of a nozzle depositing a material at a controlled rate on the last surface while it is turning could be developed for this. After adding material, the last would have to be refinished to obtain the new shape. Savings of materials, workmanship and reaction time may be very significant due to this work method. In the metalworking industries a similar technology is applied for repairing worn metal shafts. Metal is sprayed on the surface by gas or plasma torches while the shaft rotates. The shaft is refinished afterward. Labor and materials cost savings can be very large in these applications.

3. Design of a Cooperative Footwear Technology Program

Continuous growth of the standard of living throughout the world can only be achieved by continuous development of better systems for the manufacturing of necessities. Stiff competition from foreign nations with low labor rates has drained capital out of the U.S.. Footwear manufacturing companies have made larger profits by producing in countries with low labor rates, by importing from these countries and by retailing. Manufacturers of machinery have gone the same route. It was noticed during the plant visits that most modern footwear manufacturing equipment is imported from Europe by renowned U.S. machinery manufacturers.

Investments made in R&D for increased manufacturing productivity within the U.S. are not large enough to deliver the innovations necessary to keep the U.S. footwear industry competitive. However, when several companies in the footwear industry are willing to spend a small percentage of their R&D budget on cooperative research projects to meet common needs, significant research can be done. The risk involved in undertaking R&D will also be reduced significantly.

3.1 The M.I.T. - Industry Polymer Processing Program

In 1973 a cooperative research program for the American polymer processing industry was founded at M.I.T. with a seed fund provided by the National Science Foundation. [23] Professor Nam P. Suh has been the director of this MIT - Industry Polymer Processing Program since its inception. The program has now reached an annual funding level of over $500,000 through the membership fees paid by twelve U.S. companies. Since its founding, the program has provided a new focus in polymer processing by becoming a major source of new ideas, innovations, scientific and technological development, and manpower. Plastics firms associated with the program benefit from MIT's broad R&D capabilities during the development of industrial and commercial manufacturing techniques. Every participant of the Program, including faculty members, students, industrial engineers, chemists, research and corporate managers, and government representatives, has made contributions that have complemented and supplemented the strength of other participants.

A similar cooperative program can be designed for the footwear manufacturing industry. The goals of the program and a mode of operation are proposed based on the experience obtained from the MIT-Industry Polymer Processing Program and on information about the characteristics and needs of the U.S. footwear industry.

3.2 Goals of a Cooperative Footwear Technology Program

The primary goal of a Cooperative Footwear Technology Program at MIT would be adaptation of existing technologies and innovation of new technologies for the U.S. footwear industry. It is proposed that R&D projects with immediate and long range benefits for the highly fragmented footwear industries be undertaken within the context of the Program. Through the development of new technology, participating industrial firms will be encouraged to increase other R&D investment and utilize the capability of MIT's research program in developing new processes. In this manner the program will assist the American industrial firms in maintaining their national and international competitiveness. The Program will primarily concentrate on promising processes which are too expensive to be investigated by companies on an individual basis.

Cooperation on a continuous basis should also help in overcoming technical and psychological barriers to implementation of new technologies. Very often, new technologies do not find their way to practical applications because insufficient support from outside companies or organizations is given during the implementation stage. Close contacts between MIT's research program and other member companies should overcome these implementation difficulties.

Meetings organized in the context of the cooperative program must fulfill an educational function for manufacturing technologists and corporate managers. Industrial participants should grow in their inventiveness by active participation in meetings where possible new technologies are evaluated. Finally, students must be able to use part of their R&D work for their theses if the cooperative program is organized in an academic environment.

Proper design of a mode of operation for the program is very important in order to meet the program's goals. A mode of operation is proposed but is still open for discussion with candidate member companies.

3.3 Mode of Operation

The mode of operation proposed is similar to that of the MIT-Industry Polymer Processing Program [23]. Several changes are introduced to be consistent with the Cooperative Technology Program of the Department of Commerce. Thus the assumption is made that the Footwear Technology Program will be executed in an academic research laboratory dedicated to dealing with real industrial manufacturing problems. The proposed mode of operation is deemed to be most suited for providing new innovations to an industry with a long history.

3.3.1 Research Personnel

It is clearly recognized that the success of a Footwear Technology Program will primarily depend on the personnel of the Program, both faculty members and other staff members. A number of faculty members will eventually be associated with the Program when the needs of the Program require their capabilities. Research projects in footwear manufacturing undertaken by the faculty members will be funded by the Program when the work is requested by the Director of the Program.

The Program shall also employ full time R&D staff members, normally postdoctoral researchers (Research Associates). These researchers will work with research assistants who are graduate students at MIT. Research assistants are selected from the graduate student body to execute various phases of the Program under supervision of faculty members and senior staff members. Research assistants are normally allowed to take two courses during working hours and devote the rest of their time to research projects.

3.3.2 Program Advisory Council

An Advisory Council has to be established for the purpose of promoting close cooperation between the research laboratory and footwear industries. The Council will also advise the Program Director on policy matters; e.g. membership cost, technology transfer, conflicts of interest, and reviews of the Program direction. The members of the Council will be chosen to represent member firms, industrial associations, government and the MIT community. The Director of the Program will be the Chairman of the Council. Except for the charter members of the PAC, new members will be chosen by a majority vote of the PAC. PAC members will serve a fixed term of three years, except the charter members, who will serve for 5 years.

3.3.3 Solicitation of Industrial Participants

Solicitation of industrial participation will be one of the major undertakings of the Program until a sufficient number of firms join. The solicitation methods should include news releases, mailing of brochures, presentations at professional meetings, personal contacts, and write-ups in trade journals. The firms to be solicited will be chosen so that they represent a well-balanced mixture of large and small companies with businesses in various aspects of footwear manufacturing. Any American firm in the footwear manufacturing industry that agrees to abide by the by-laws and requirements of the Program will be guaranteed membership upon application.

The experience gained through the MIT-Industry Polymer Processing Program indicates that it is much easier to recruit new member firms once the technical capabilities of the Program are demonstrated in terms of results. This is one of the compelling reasons for moving into operation as soon as possible.

All industrial firms should be asked to make a two-year commitment to assure the continuity of research projects over a reasonable period of time.

There are many factors which influence the decision of a firm to join or to continue to participate in a cooperative program. These factors can be separated into three groups: 1) factors directly attributable to the Program, 2) general business climate of the industry, and 3) factors arising from internal corporate policies which are not related to the Program. This third factor makes it mandatory that the Program be provided with a sustaining operational fund over a long period of time. Otherwise the day-to-day operation of the Program will be too dependent on the decisions of a few member firms and thus prevent the Program from delivering meaningful results. The importance of governmental support for several years cannot be overemphasized.

3.3.4 Mechanisms of Interactions between Members

Several mechanisms of interactions between the Program and industrial sponsors have to be established. These mechanisms have been found to be mutually satisfactory both to industrial members and MIT during the Polymer Processing Program. The mechanisms are Quarterly Review Meetings, the Program Advisory Council meetings for policy matters, and informal meetings and visits to discuss specific technical problems.

3.3.4.1 Quarterly Meetings

The purpose of the Quarterly Meetings is to present new ideas, results of the Program, the work plan, and to discuss other matters of mutual interest. At these meetings new developments in related areas will also be reviewed. The flow of proprietary technical information is only from the research organization to member firms. This is intended to eliminate the cumbersome aspects of receiving proprietary data from member firms.

3.3.4.2 Program Advisory Council Meetings

Meetings of the Program Advisory Council are essential in establishing and correcting the program's financial and organizational control systems. Membership fees, policies on patents, mode of royalty distribution, and effectiveness of the program would be discussed in these meetings. Once every six months a Program Advisory Council meeting should be held.

3.3.4.3 Informal Meetings and Discussions.

Many urgent matters can not be postponed for discussion on Quarterly meetings. Therefore many direct contacts between the research center's personnel and industry must be encouraged. These meetings are an essential part of the cooperation between companies and the research center.

3.3.5 Patent Rights and Royalty Distribution

An important element in the Program is the establishment of prerequisites for greater R&D investment by the private sector. During the MIT-Industry Polymer Processing Program it was experienced that the most crucial prerequisite is a realistic patent policy. The patent policy must be such that it provides incentives for member firms to invest in the Program and subsequently (or concurrently) in their own further development projects so as to exploit the new technology generated by the Program. For example, the patent policy below has been formulated for the MIT - Industry Polymer Processing Program.

3.3.5.1 Patent Rights

MIT presently has a viable patent licensing program which actively seeks to promote the utilization of MIT patents in a manner most likely to effect a meaningful transfer of technology. MIT patent policy has been established to insure that those inventions in which MIT has an equity will be utilized in a manner consistent with the public interest. MIT believes that the retention of the title along with a policy of non-exclusive licensing at reasonable terms is the best way of insuring, under most circumstances, that the public interest is safe-guarded. Therefore, potentially valuable inventions are made available to responsible licensees at reasonable cost; this insures the benefit of the public in its role as a consumer and user.

Inventions made in the course of the Program shall be promptly reported for evaluation to government, member firms and MIT. On those inventions where patent protection is determined by MIT to be desirable, MIT shall promptly file a domestic patent application within a year of its disclosure. Patent applications in foreign countries shall also be filed on the same invention within the same period if the filing of the applications is deemed necessary by MIT. In order to avoid the undesirable and cumbersome aspects of the joint ownership of patents and to fully and efficiently utilize MIT's existing patent licensing program, title to all inventions made in the course of research shall vest in MIT with a royalty-free, non-exclusive, irrevocable license to use to the sponsors including government who participated in the Program in the year in which the invention is made. Licenses will also be available to responsible non-member firms at reasonable terms. All inventions made by the Program shall be integrated into MIT's licensing program.

MIT shall grant to the U.S. Government a non-exclusive, irrevocable, non-transferrable paid-up license to make, use, sell, practice or cause to be practiced throughout the world by or on behalf of the U.S. Government (including any agency thereof) each subject invention.

MIT recognizes the right of the U.S. Government to require 1) assignment of a patent to the U.S. Government, 2) cancellation of any outstanding licenses under the said patent, or 3) the granting of licenses under said patent to applicants on a non-exclusive basis on terms that are reasonable in the circumstances, or 4) any combination of the above, in the event that MIT, its licensees, or assignees has not taken effective steps within three years after a patent issues on a subject invention to bring the invention to the point of practical application or has not made the invention available for licensing on terms that are reasonable in the circumstances or cannot show cause why the principal or exclusive rights should be retained for a further period of time.

MIT shall obtain patent agreements to effectuate the provisions of this article from all persons in the Program who perform any research and development work being funded by government.

3.3.5.2 Royalty Income

All royalties earned on the licensing of such inventions are divided among the parties as follows:

a) Of the total net royalties earned on such inventions, 25% shall be due MIT for unrestricted use. Of the remaining 75%, each industrial sponsor who is then a participant in the Program at the time the invention is made, shall be due a percentage determined by the ratio of that sponsor's monetary support to the total cost of the research program in the year in which the invention is made. The balance of such royalties shall be due MIT for continued support of the research program for as long as the central R&D organization remains at MIT, after which such balance shall then be due MIT for unrestricted use.

b) The term "net royalties" is defined as the gross royalties earned by MIT on a licensed invention, minus any litigation costs, interference costs and marketing costs to specifically exclude salaries, overhead and usual internal operating expenses of MIT's patent licensing program.

3.3.6 Selection of Specific Projects

3.3.6.1 Philosophical Aspects of Project Selection

The success of technical projects hinges on proper choice of specific projects. Projects should be chosen after consideration of both their technical merits and their industrial viability by the Director of the Program. The selection of specific projects should be based on the evaluation of the following factors: 1) The long term needs of the footwear industry, 2) specific needs of the member firms, and 3) educational and intellectual values of the project. Although it is clearly impossible to meet all the anticipated needs of member firms without sacrificing the long term goals of the Program, their needs should be carefully evaluated since the adoption of new inventions made by the industry will be closely tied to the needs and markets of the firms.

A mixture of long and short term projects should be chosen. Successful short term projects are necessary if the member firms are to justify their support of the Program to their stockholders. Long term projects would be of a high risk nature, but with the potential for major productivity increases in the footwear industry.

Major R&D investments in any one of the projects should be made only after the basic ideas are thoroughly tested. In most cases key ideas should be pursued rather than undertaking a project for the purpose of analyzing the existing processes unless there is a clear need for the analysis. When the scientific foundation in certain critical areas is not available, basic scientific research must be undertaken with the view of applying the findings to processing applications.

Successful projects must be executed to a point where industrial firms can utilize the work. The major emphasis of the Program should be on demonstration of new ideas and processes rather than development of final products. The degree of development required is expected to depend on the nature of application, the amount of capital investment required for commercialization, the outside interest the investor can generate among non-member firms, and the complexity of the technology. Therefore, decisions on the termination of a given project will be made after evaluating all these factors.

3.3.6.2 Ideas for Projects

Most of the key ideas for projects will probably be advanced by the R&D staff members of the Program. Suggestions and advice of the member firms will be actively solicited. The R&D staff members of the Program will be exposed to current literature and industrial developments through judicious attendance at conferences and exhibitions. Since the innovative process is random it is difficult to predict the future course of action.

The Director of the Program is responsible for final choice of projects, subject to the approval of the governmental project officer of the Program, as well as the personnel on the project. Input from industrial members will be taken under advisement.

3.3.7 Dissemination of the Results of the Program

To fulfill the objectives of the Program and of the academic research organization as a higher learning institution, the findings of the Program should be made available to the member firms and to the public.

Through Quarterly Meetings and other mechanisms of interactions discussed in Section 3.3.4, the findings of the Program can be presented to member firms orally. Written reports on the findings of the Program should be distributed to member firms annually. In order to provide as much lead time as possible to the member firms, early disclosure of ideas and results must be emphasized.

After insuring the proper protection of the rights of the member firms and the research organization through the filing of patent applications etc., the findings of the Program will be made public through presentation of papers at conferences and in journals. In some cases, the findings will be published in the form of a book.

For proper dissemination of the results of the Program it is recognized that the prompt filing of patent applications is essential. Patent applications will have to be filed prior to the submission of specific theses by students whose patentable results were obtained by participating in the Program.

3.3.8 Evaluation of the Program's Effectiveness

A government representative can play the most important role in evaluating the Program's effectiveness by attending Quarterly meetings and the meetings of the Program Advisory Council. However, growth of the Program by industrial support will be the best indicator of its significance for industry. A few years after the initiation of the Program the increase in manufacturing productivity due to the Program can be evaluated by sending out questionnaires and by visiting the member companies.

CONCLUSIONS

Automation of footwear manufacturing has been very difficult because of the wide variety of sizes and shapes of shoes, the dependence of styles on fashion, and the many different kinds of flexible materials used. The industry has remained highly labor-intensive and low capital-intensive. Rising costs of labor in the U.S. stimulated corporations to make use of foreign low-cost labor. Almost no further investments were made in Manufacturing Research and Development.

For the U.S. Footwear Manufacturing Industry to survive, several measures must be taken to intensify the advantage of manufacturing domestically. Technologies compensating domestic high labor rates must be developed and put into operation very soon. The fashion reaction times and quality must improve. Concepts for improving existing equipment and factories on a short-term basis are proposed in this report. These apply to materials utilization, materials testing, operations productivity, computer assisted management and training of workers. Close cooperation between inventors, machine designers, footwear manufacturers and government is necessary to quickly convert ideas into practical techniques. The long-term future of the footwear industry has to be secured by synergistic effects of R&D in computers, processes, and materials.

During the last five years computer technologies have opened a new horizon for economical and adaptive automation. The cost of computers has dropped so drastically that every company can afford them. Applications for footwear design and footwear manufacturing are numerous as shown in this report. A decrease in time required for introducing a new style is the major benefit from computer aided design and computer aided manufacturing. It gives the U.S. footwear manufacturers a lasting advantage over competitors in locations remote from the market.

New methods for cutting, stitching, trimming, etc. should be developed. Examples show that productivity can be increased.

The vast raw material resource of the U.S. should be employed efficiently. Technologies for materials flaw detection, correction of flaws and quality upgrading are necessary.

The computer revolution should take place very soon but R&D investments in software, processes and materials are necessary to make it happen. None of the U.S. footwear manufacturers is able to bear the cost of the required R&D on its own. Therefore, a Cooperative Footwear Technology Program is proposed. Initial funding from the Department of Commerce and continuous funding from companies should be obtained in order to start the Program at M.I.T. The Program should secure a continuous development of more productive technologies for the U.S. footwear industry. The U.S. is expected to benefit from the Program by a growth in domestic footwear production. Ultimately, mankind will benefit from the R&D program. Throughout the world, real growth in the standard of living can be achieved by inventing and applying better manufacturing technologies.

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A STUDY OF COMPETITIVE BUSINESS STRATEGIES AND TECHNOLOGICAL ADVANCEMENT IN THE U.S. NONRUBBER FOOTWEAR INDUSTRY

for the

National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

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May 15, 1978

CONTENTS

TABLES AND CHARTS

INTRODUCTION

Dr. Harry L. Hansen, of the Harvard School of Business Administration, wrote.* in 1958, "The Shoe Industry . . . is, to many manufacturers. more a way of life than an economic sensibility."

Dr. Hansen concluded that shoe manufacturing companies('):

* were undercapitalized with one-third of all companies showing losses (see Table No. 1);
* were operated in antiquated factories;
* had inadequate management, due, principally, to a lack of business training;
* owners looked upon making shoes as a means of creating personal wealth rather than building a business;
* managers had little knowledge of the market place or of what the customer would like to buy;
* executives lacked the lines of communication to make them more competitive.

Nathan Stix, former Chairman of the United States Shoe Corporation, commented recently,* that "ten to twelve years ago the domestic shoe industry was complacen The manufacturers had things pretty much their own way and made what they wanted."

Stix said "We made pumps until nobody would buy them." At this point, shoes from Europe began to be imported which were new and different in terms of style as well as low in cost. The domestic manufacturers could no longer sell the shoe styles they had manufactured with little change, year after year, and the import penetration increased to the point it has reached today, (see Table No. 2). Stix further states that the domestic manufacturers are now awake and ready to compet

* A Study of Competition and Management in the Shoe Manufacturing Industry, prepared for the National Shoe Manufacturers Association, 1958.

* Synoposium on Footwear Industry Concepts, United States Shoe Corporation, Cincinnati, Ohio, April 4-5, 1978.

Can the American shoe manufacturer move into the twentieth century and become a strong competitive force, offering products with style and quality which the consumer will buy? Will old factories be revitalized and new plants opened thereby increasing the number of job opportunities for Americans? We believe the answers are "yes", but these goals can be accomplished only with substantial assistance from the government and a reorientation of the direction and activities of the entire industry.

Our analysis has been directed principally towards actions to assist the small to medium size shoe manufacturer become more competitive. However, since, to accomplish this, we believe that all manufacturers (large, medium and small), retailers, and suppliers must work together, we have considered steps that should be taken to improve communications and lay the groundwork for increased profits for all companies in the industry.

Table No. 1

F A C T S   A N D   F I G U R E S

INCOME RETURNS AND NUMBER OF ESTABLISHMENTS OF FOOTWEAR OTHER THAN RUBBER

(All money figures in thousands of dollars)

	Gross Income	Gains	Losses	Net Gain	% Profit on Gross Income	No. of estab. showing gains	No. of estab. showing losses	To repo fact
1960								
1959								
1958	$2,239,164	$ 94,822	$ 13,720	$ 81,102	3.62%	699	374	1,07
1957	2,208,059	101,370	6,793	94,577	4.28	634	250	88
1956	2,192,944	103,559	8,452	95,107	4.34	690	337	1,02
1955	2,085,838	105,044	4,982	100,062	4.80	707	275	98
1954	1,904,141	88,609	5,523	83,086	4.36	645	252	89
1953	2,009,982	85,481	6,769	78,712	3.92	671	371	1,0
1952	2,084,844	89,086	7,479	81,607	3.91	828	246	1,0
1951	2,079,834	88,607	9,087	79,520	3.82	629	366	9
1950	1,873,284	101,449	5,705	95,744	5.11	673	344	1,0
1949	N o	s t a	t i s	t i c s		a v a	i l a	b l
1948	1,843,559	90,956	13,965	76,991	4.18	638	463	1,1
1947	1,953,797	121,414	11,241	110,173	5.64	908	507	1,4
1946	1,678,356	117,553	3,891	113,662	6.77	1,029	296	1,3
1945	1,326,117	77,574	702	76,872	5.80	[illegible]6	117	9
1944	1,284,304	74,782	626	74,156	5.77	801	114	9
1943	1,247,853	81,647	695	80,952	6.49	821	97	9
1942	1,241,553	76,709	1,441	75,268	6.06	750	190	9
1941	1,028,113	46,384	3,102	43,282	4.21	698	286	9
1940	769,511	29,108	6,292	22,816	2.96	492	480	9
1939	717,328	28,369	6,225	22,144	3.09	387	403	7
1938	677,156	17,403	6,866	10,537	1.56	359	455	8
1937	805,706	24,442	6,112	18,330	2.28	485	601	1,0
1936	742,516	30,594	5,781	24,813	3.34	543	555	1,0
1935	688,352	28,281	5,215	23,066	3.35	505	591	1,0

Source: Bureau of Internal Revenue

Table No. 2

Table No. 2

U.S. Nonrubber Footwear Consumption

(Millions of Pairs)

Year	Domestic Production	Exports	Imports	Apparent Consumption	Imports as % Of Consumption	Per Capita Consumption (No. of Pairs)
1966	641.7	2.7	96.1	735.1	13.1	3.8
1967	690.0	2.2	129.1	726.9	17.8	3.7
1968	642.4	2.4	175.3	815.4	21.5	4.1
1969	577.0	2.3	202.0	776.7	26.0	3.9
1970	562.3	2.2	241.6	801.7	30.1	3.9
1971	535.8	2.1	268.6	802.3	33.5	3.9
1972	526.7	2.3	296.7	821.0	36.1	3.9
1973	490.0	3.6	307.4	793.8	38.7	3.8
1974	453.0	4.0	266.5	715.5	37.2	3.4
1975	413.1	4.6	286.4	694.9	41.2	3.3
1976	422.5	6.0	369.8	786.3	47.0	3.7
1977	385.0	5.4	368.0	747.6	49.2	3.45

Note: 1973 - 1977 excludes disposable footwear

Recommendations

As a result of our analyses, we are making five strategic recommendations, two of which are directed towards benefiting all segments of the shoe industry, namely our recommendations for:

1. Formation of a National Shoe Industry Council and,

2. A Continuing Education Program,

and three which are directed at improving the competitiveness of the small to medium size shoe manufacturer, namely our recommendation for:

3. Establishment of a Market Research and Styling Consulting Group, and,

4. A plan to lower the cost of leasing or buying shoe machinery,

5. Organization of a shoe industry Centralized Purchasing Office (CPO) for small to medium size manufacturers.

We also recommend continuance of the three programs, implemented by the Commerce Department, namely:

6. Management Consulting to impacted manufacturing companies,

7. Financial assistance to such companies.

8. The program to increase exports.

Following are our comments on each of these recommendations:

Recommendation No. 1

Formation of a National Shoe Industry Council

Our study of the shoe industry, and of present trade associations, indicates that there is no one "voice" continually representing the views of the industry to its various publics.

We recommend that a new and all encompassing industry group be established, which we have called the National Shoe Industry Council (NSIC). Membership would consist of up to fifty individuals who are leaders in their respective segments of the industry. There should be a conscious effort to balance membership between large and small shoe manufacturers; large and small retailers; and individuals from equipment and other suppliers, so that all segments of the industry are represented.

The principal objective of NSIC should be to develop position papers on various matters of importance to the entire shoe industry. Also to take such other actions as may be judged to be in the best overall interests of the industry.

We suggest that NSIC be a totally separate organization and not be aligned with any present association or organization. Funding of staff should be by the Commerce Department for a minimum of five years.

The rationale behind such an organization is the necessity of developing a coordinated program for the shoe industry. The quality, style and price of foreign shoes was a major reason for the substantial increase in imports over the past decade. Now that the price advantages are narrowing, as the costs of foreign producers have increased, and the quality and style of American shoes have improved, an NSIC can become an important voice in the rebuilding of the American shoe industry.

We recommend that a small task force of leading shoe manufacturers, shoe retailers, and suppliers, assisted as required by the Commerce Department, be selected to organize and implement this program.

Recommendation No. 2

A Continuing Education Program

We propose that a special comprehensive program of Continuing Education be established for shoe manufacturing and shoe retailing executives as well as officers from companies in other segments of the shoe industry. These programs would take place at three graduate schools of Business Administration, located in the East, in the Middle West and on the Pacific Coast, (such as Harvard, Northwestern and Stanford, for examples).

We recognize that AFIA has run three day annual market seminars for industry executives which have been well received. However, we believe that a 2 to 3 week Management Development course would have substantially greater benefit to the participants as is suggested by the results indicated in 3 below.

The general objectives of our Continuing Education program would be the following:

1. To provide shoe industry management training (or retraining) in the most advanced business techniques, particularly related to marketing, finance and business administration;

2. To offer a forum for the exchange of ideas between executives of all segments of the shoe industry.

We believe such a program would achieve the following:

1. Prepare manufacturers, retailers, and others in the shoe industry to be more competitive in the years ahead;

2. Develop a better understanding, among executives from all segments of the industry, of their respective problems, and create an atmosphere in which they can work together to solve these problems.

Attendance at each session would be divided equally between small and medium size shoe manufacturers and large manufacturers; small and medium size shoe retailers and large retailers; and other industry representatives and would be limited initially to senior officers of the companies involved.

Professor Kenneth R. Andrews of the Harvard Business School wrote a book entitled, "The Effectiveness of University Management Programs".

Though this work was published in 1966, the office of Dean Richard L. Nohl of the Continuing Education Program at Harvard Graduate School of Business Administration believes the results are applicable today.

ased on our firm's 37 combined years experience in the shoe industry, we lieve several arguments might be advanced by industry executives for not tending such sessions, each of which are subjects of the surveys conducted · Professor Andrews:

"I am too old to attend"
Exhibit 10 on page 301 (see page 9), indicates that the "favorability index" reaction of students to the benefits of the programs, ages 30 and younger through 55 and older, varied by less than 1/2 of 1%. *

"I am only a high school graduate"
Table IV-23, page 110 (see page 10), indicates that participants, with educational backgrounds ranging from elementary school through Doctors degree, are almost equally pleased with the results obtained from such programs. *

"I attend seminars now, would I learn more at a business school?"
Table IV-8 (see page 11), shows that over 81% of all who attended Formal Management Development Programs felt they were superior to other extra-curricular activities. *

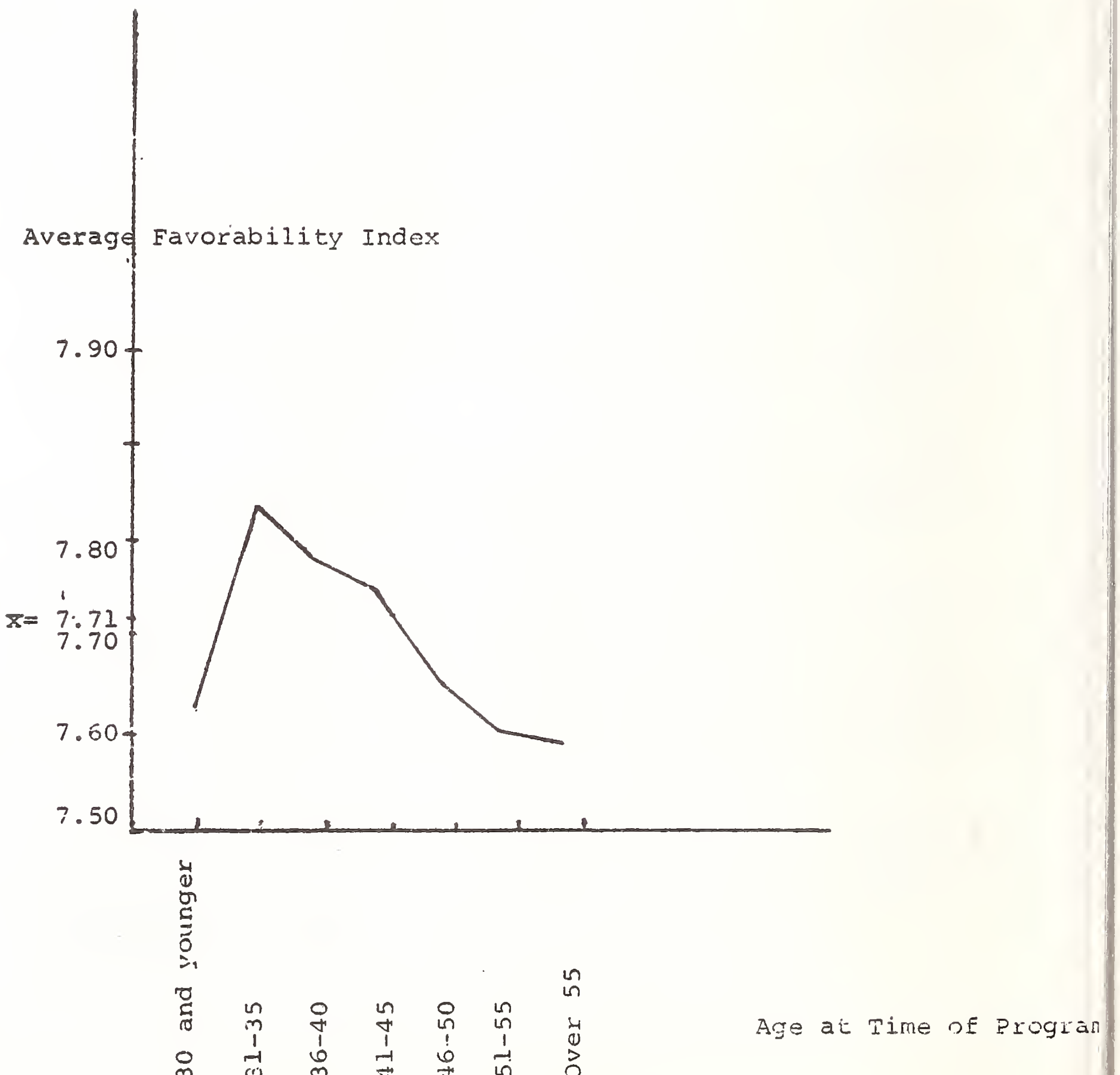
"I can't spend much time away from my business"
Tables IV-1 and IV-2 (see page 12), illustrate that a short program (of 2-3 weeks) appears to be as beneficial to attendees as long programs. *

ır concept is to have successive two week shoe industry programs, repeated ur times a year. The content could be modeled on existing management velopment programs, with those modifications necessary to focus on the specific eds of the shoe industry. We would propose that the Commerce Department fund e cost of preparing agenda for these programs, and for making arrangements th the schools involved with the cost of the first two years program, except r living expenses of the participants, borne by the Commerce Department.

rom "The Effectiveness of University Management Programs" by Professor enneth R. Andrews, Donald K. David - Professor of Business Administration, arvard University, Boston, 1966.

Exhibit 10 p. 301

Age of Respondents at Time of Program
Compared to Favorability Index



SOURCE: "The Effectiveness of University Management Programs," Kenneth R. Andrews

TABLE IV-23

AMOUNT OF FORMAL EDUCATION AND FAVORABILITY

Men who completed:	Average Favorability Score
Elementary school	8.5
Junior high school	7.6
High school	7.9
1 year college	8.0
2 years college	7.9
3 years college	7.8
4 years college	7.6
5 or more years college	7.6
Men with:	
High school diploma or more	7.9
Bachelor's degree only	7.6
Law degree	7.9
Master's degree	7.4
Doctor's degree	7.2

SOURCE: "The Effectiveness of University Management Programs," Kenneth R. Andrews

Table IV-8

Hindsight Order of Preference for Developmental Activity

Activity	Number of First Choices	Per Cent	Average Rating*
Attending seminars and workshops of professional groups (such as the American Management Association)	445	7.3%	2.4
Time off to study individually	89	1.5	4.4
Attendance at a technical course to refresh specialized knowledge	189	3.1	3.5
Scheduled visits to other companies to study their operations	348	5.7	3.0
Attending the university-sponsored executive development program which you later did attend	4,917	81.0	1.3

*1.0= first choice
2.0= second choice, etc.

SOURCE: "The Effectiveness of University Management Programs," Professor Kenneth R. Andrews

Tables IV-1 & IV-2

GENERAL ATTITUDES AND REACTIONS

After a Few Days at the Program

Length of program	Favorable	Mixed	Unfavorable
9-13 weeks	58.4%	22.5%	19.1%
8 weeks	64.1	20.4	15.5
6 weeks	68.9	19.3	11.8
4-5 weeks	62.6	22.0	15.4
2-3 weeks	77.4	13.3	9.3
All schools	64.3	20.6	15.1

At the End of the Program

Length of program	Favorable	Mixed	Unfavorable
9-13 weeks	73.5%	17.9%	8.6%
8 weeks	70.5	21.6	7.9
6 weeks	71.1	19.6	9.3
4-5 weeks	73.3	16.4	10.3
2-3 weeks	74.4	20.3	5.3
All schools	72.3	19.2	8.5

SOURCE: "The Effectiveness of University Management Programs," Professor Kenneth R. Andrews

Recommendation No. 3

Market Research and Styling Consulting Group for small to medium size shoe Manufacturers.

Starting with the first shopping center in 1968 there has been a strong trend towards suburban shopping through multiple expansion at existing department stores and at new chains of discount department stores. Selling these major outlets calls for more exacting marketing skills to meet their requirements of quantity, price and delivery, even if a superior fashion item can be produced.

In addition, during the last decade, an increasing number of pairs of shoes have been distributed through leased departments, owned by the larger manufacturers, and the number of independent shoe stores have decreased. Another factor has been that most of the new retail stores in shopping malls are part of chains owned by various large manufacturers.

All of these major changes have made marketing research for small to medium size manufacturers a most important function for long range success.

Chart 1 shows the growth of department stores, including discount department stores, during the period.

Chart 2 shows the rise in leased departments.

Chart 3 shows the growth of large multi-unit retail shoe store chains.

The small to medium size shoe manufacturer has neither the staff, the experience nor the money to undertake comprehensive market research and styling studies. In addition, many owners or senior officers of such companies, with backgrounds in manufacturing or sales, do not have the expertise to effectively undertake programs to reach their markets without professional assistance.

The establishment of a centralized market research and styling group would provide management of small to medium size companies with access to experts in marketing and styling. Advice and counsel of these experts would permit manufacturers to implement plans to identify and take advantage of new opportunities for penetration of the changing retail markets.

We recommend that this group be established as an independent organization funded by the Department of Commerce for a minimum period of five years. The group would work with small to medium size manufacturers in the following areas:

1. Preparation of market research studies;

2. Selection of an in-house or outside consultant to carry out such studies;

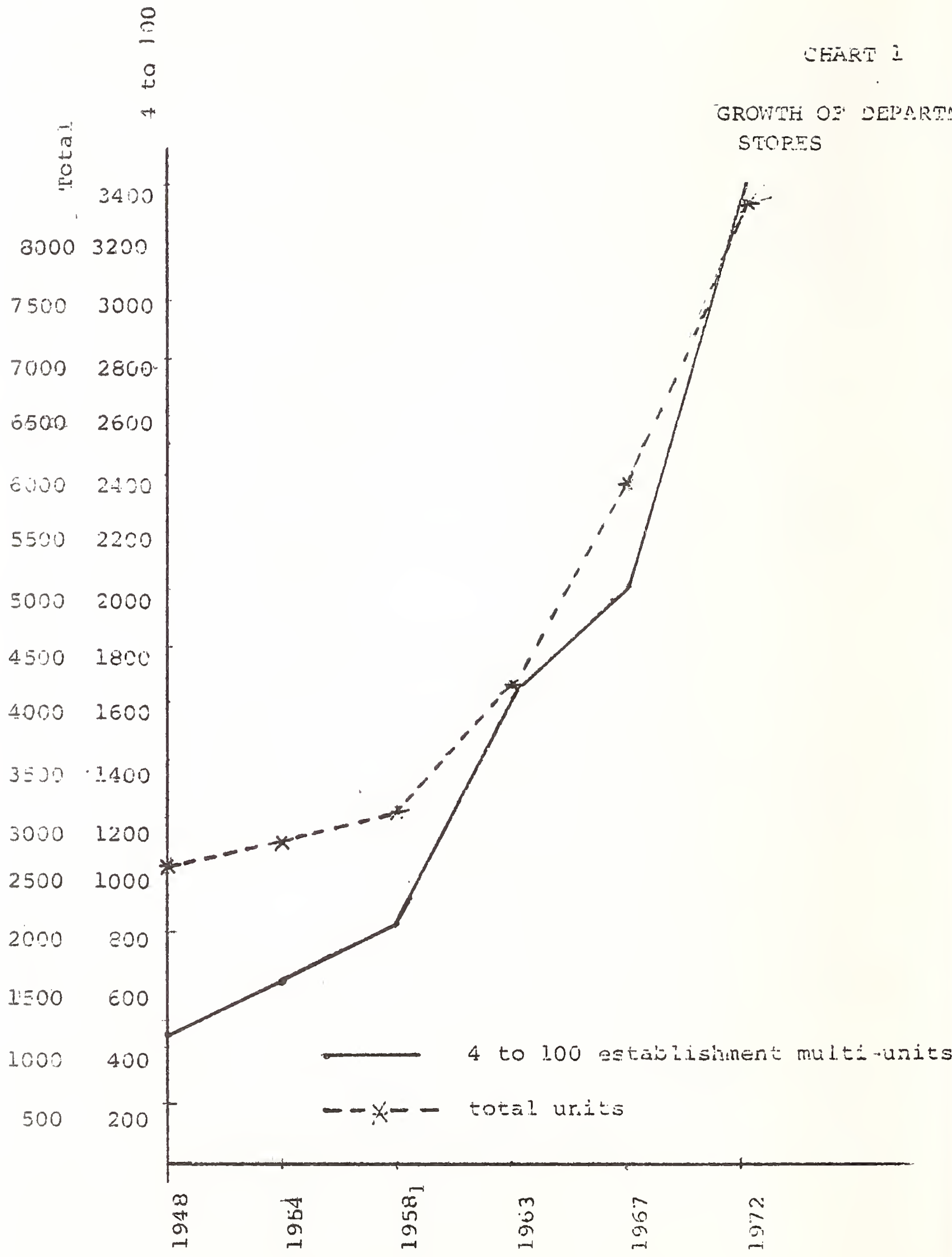
3. Analysis and dissemination of study results;

4. Assistance to individual companies in positioning them in the market (based on the research results) and development of the styles that will fulfill the needs of the selected target market segment.

Staffing should never exceed 50 people (consultants and clerical). Funding requirements in 1977 would have been in the range of $2,000,000. The group would be expected to substantially improve the competitiveness of the small to medium size shoe manufacturer by supplying missing marketing and styling staff support.

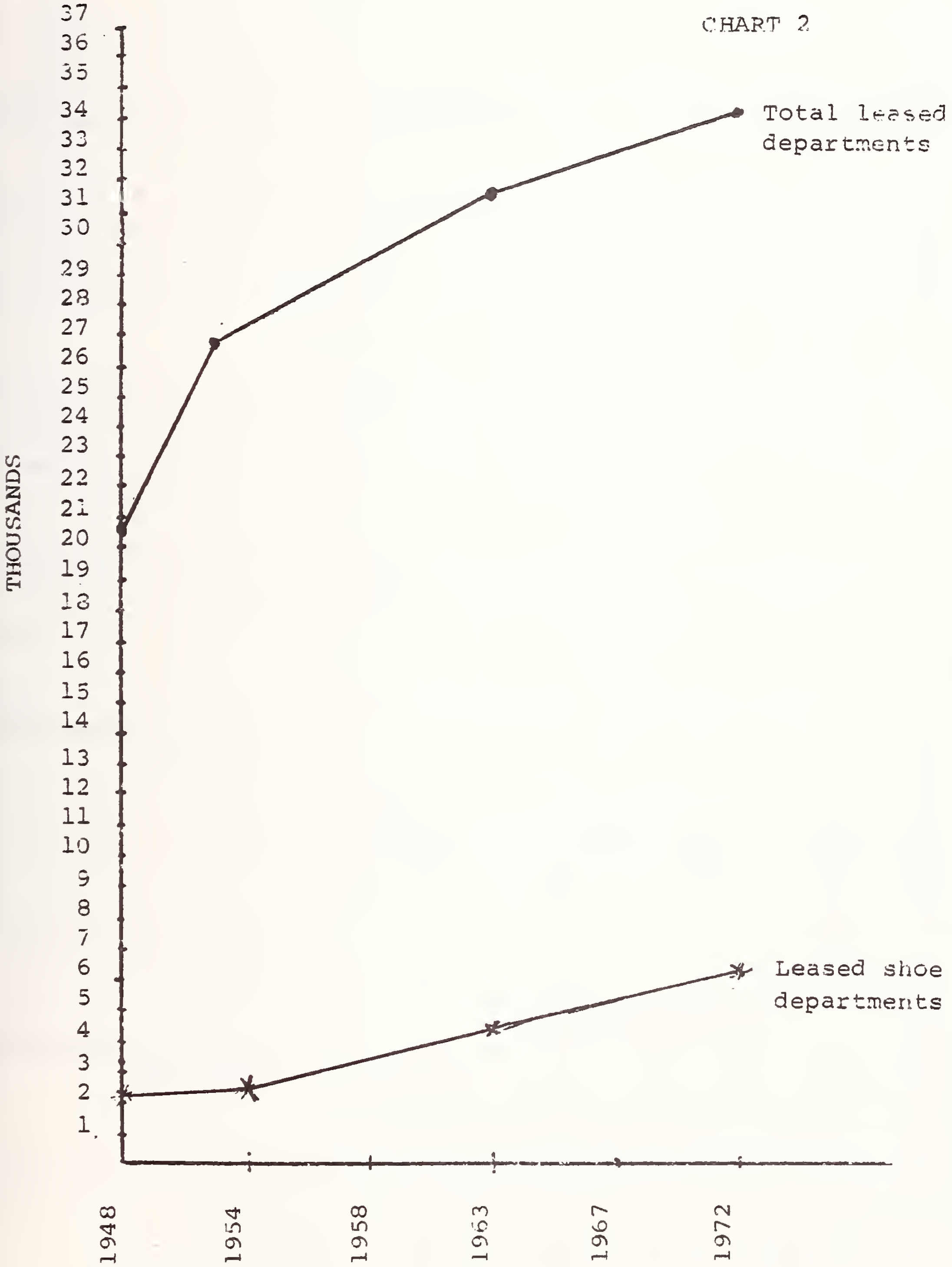
CHART 1

GROWTH OF DEPARTMENT
STORES



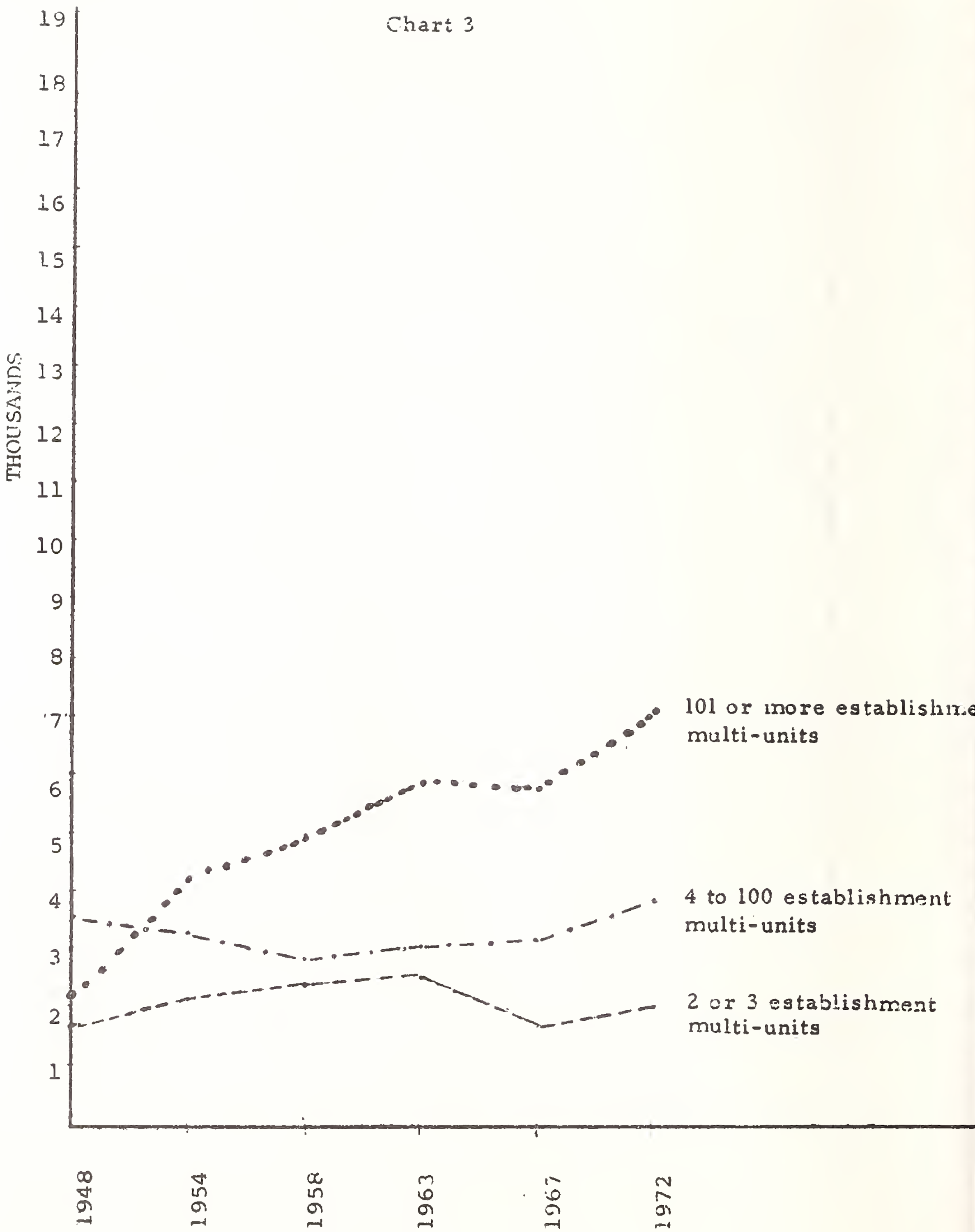
SOURCE: Census of Business

CHART 2



SOURCE: Census of Business

Chart 3



SOURCE: Census of Business

ecommendation No. 4

plan to lower the cost of lease or conditional sales contracts for shoe machinery r small to medium size shoe manufacturers

'e recommend that a plan be developed for small to medium size manufacturers lease, or purchase on conditional sales contracts, the latest shoe machinery om several major leasing companies, not presently in the business of discounting ase or conditional sales contracts of shoe manufacturers. Objective of this plan ould be to provide such manufacturers the opportunity to lease or purchase shoe achinery over a period of years on the most favorable terms and conditions.

e recommend that the government guarantee a sufficient percentage of the rtfolio of the shoe machinery contracts, held by each leasing company. Each ch company can then assume marginal credit risks at lower than normal interest tes and on longer than traditional terms, resulting in low monthly costs for oe manufacturers.

ach contract should, at the manufacturer's option, have installation and equip-ent start-up costs included to minimize the impact on working capital.

e reasons behind our recommendations are principally two-fold:

Enable the small to medium size manufacturer to modernize his factory on e most favorable financial terms and with little or no outlay of working capital;

Permit shoe machinery builders to sell their equipment to established leasing mpanies on a non-recourse basis (because of the government guarantee) and to ply the credit or funds generated thereby to research and development programs r new generations of machinery to further improve the competitiveness of all oe manufacturers.

Recommendation No. 5

Organization of a shoe industry Centralized Purchasing Office (CPO) for small to medium size manufacturers

Many products, purchased by the small to medium size manufacturers, are used by most companies in producing shoes. Examples would be shoe boxes, lacings, counters, box toe material, adhesives, thread and the like.

Large manufacturers have the volume of business to obtain certain concessions in price and billing terms, which can not be secured by the smaller producers.

We recommend that a study be made, by a joint manufacturer/Commerce Department task force, to determine the feasability of establishing a CPO so that small to medium size manufacturers will have buying power on certain of their requirements equivalent to that of the majors.

We also recommend that consideration be given to having the CPO owned jointly by all the small to medium size manufacturers who participate in the program with profits, if any, distributed to each "owner" annually based on each manufacturer's percentage of the total business handled by the office. In this way, a manufacturer will profit from the savings on business processed through CPO and will have a further incentive to participate through sharing in profits of the enterprise.

Management of the CPO would be vested in a Board of Directors selected by the manufacturers.

We recommend that the initial capital for setting up the CPO be supplied by the Commerce Department in the form of a term loan, to be repaid from the first profits of the operation.

In practice, the CPO would place volume orders, based on bids by suppliers, to be drop shipped to the individual shoe manufacturer who would be responsible for payments. Credit responsibility would be that of the supplier who would be required to make his own judgement on the credit worthiness of each manufacturer being sold after the volume order had been placed by the CPO.

Recommendation No. 6

Improving the efficiency of impacted shoe manufacturers

The establishment of the "FIT" program, directed at small to medium size manufacturers, should be continued. By providing "on the job" management assistance, the Commerce Department will enable many manufacturers to become profitable and successful employers of an increasing number of American workers.

This program, which we consider to be closely involved with the financial assistanceprogram, will not only help present manufacturers to improve their operations, but encourage new entrepreneurs to enter the shoe industry.

Recommendation No. 7

Long term Capital Loans

The capital loan program of the Commerce Department will provide many manufacturers with the funds they require to refurbish their plants and restore working capital.

Recommendation No. 8

Encouraging Exports

Unlike the export orientation of the majority of other American industries, little attention has been given to the potential for exporting American shoes, particularly branded footwear.

The Commerce Department's plan of assisting the shoe industry in exploring the potential for shoe exports is one that should bear fruit in the years ahead and should be pursued aggressively.

Summary

The increasing costs of producing footwear overseas and the support being given to the shoe industry by the government is giving owners and/or managers of American small to medium size manufacturing plants a "second chance" to become a competitive factor in the years ahead.

With the implementation of our recommendations for assistance in marketing and styling, the development of a low cost equipment lease or conditional sales contract programs and the establishment of a Centralized Purchasing Office, the small to medium size manufacturer should have new tools to lower costs and increase sales.

Our recommendation of a University sponsored Management Development program, which we have called "Continuing Education", could become an important factor in improving the management skills of executives in all branches of the industry and lay the groundwork for improved communications through "one-to-one" meetings of executives at such programs.

By establishing a National Shoe Industry Council, the industry will have "one voice to develop coordinated programs to benefit manufacturers, retailers, and supplier alike and to make the American industry a more competitive factor in the world of shoes.

We submit these recommendations while urging the continuance of the Commerce Departments present programs of management and financial assistance to impacte factories and the program of promoting exports.

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A BUSINESS STRATEGY TO ENHANCE THE COMPETITIVE POSITION OF THE U.S. NONRUBBER FOOTWEAR INDUSTRY

FOR

The NBS Shoe Team
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C.
Contract Order No. 80836

Prepared by

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Zinder Energy Management, Inc.
Washington, D.C.

May, 1978

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May 22, 1978

Ms. Margery H. King
Manager NBS Shoe Team
Office of the Director
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

Dear Ms. King:

Pursuant to our purchase order contract, we are submitting this report to you on the results of our efforts to develop business operating strategies to enhance the competitive position of the U.S. nonrubber footwear industry.

I suppose it is axiomatic that such ventures never turn out the way we anticipate they will. Nevertheless, I must say I am surprised to find myself touting the formation of cooperative enterprises, an area of business I have never paid much attention to. It certainly confounds that ancient saw that "you can't teach an old dog new tricks."

I trust you will not classify the report a dog. In any event, best of luck with the project.

Sincerely,

Bill Yost

Table of Contents

A BUSINESS STRATEGY TO ENHANCE THE COMPETITIVE POSITION OF THE U.S. NONRUBBER FOOTWEAR INDUSTRY

I. Introduction

Everyone is familiar with the plight of the U.S. footwear industry. In the past 20 years imports have grown from four percent to essentially 50 percent of the shoes sold in the United States. A shake-up has occurred in the U.S. industry with many footwear manufacturing firms failing to meet the test of the increased competitiveness caused by both the imports and the response by the U.S. footwear industry to imports. The level of competitiveness has risen for everyone concerned. Some companies -- both large and small -- have failed as a consequence. But, this happens in every business, in every industry. It's the nature of our economic system.

At the same time, it is very difficult, and probably foolish to make generalized statements about an industry as fragmented and highly diverse as the footwear industry, comprised as it is of over two dozen different types of products in five or more price ranges. Companies range in size from billion dollar giants down to small entrepreneurial operations employing a few dozen people. Given these circumstances, variations in management skills, financing, labor markets, etc., it is not surprising that not all footwear manufacturers have suffered deeply, or even suffered at all, in the competition the industry is experiencing. Some companies' profits have increased as others are forced into bankruptcy.

Some say let the weak go, but in the face of foreign government support for their footwear manufacturers how fair is the competition? We are faced with two questions:

What should be done?

What can be done?

In this paper we duck the first question and will concentrate on what can be done.

To address the "What Can Be Done?" question, we begin with the retailer. Some say, perhaps unfairly, that the retailer is the malevolent force that holds the key, or perhaps the throat of the struggling manufacturer, in this situation. Actually, the market place competition holds the key and the retailer must respond to it with his own strategy for success just as the manufacturer must have a strategy to succeed. Therefore the question is: What strategy will help a manufacturer survive and even prosper in today's business environment in the footwear industry?

In the balance of this paper we will attempt to describe the business environment as it relates to the manufacturer in greater detail. We will then propose a possible strategy for increasing the manufacturer's competitiveness in the business environment that we have described. And lastly, we will make suggestions for implementing the business strategy proposed.

II. Business Environment

In this section we will describe four areas of business environment affecting the footwear manufacturer. One, what does the customer (retailer) want from a resource (manufacturer)? Two, what are the critical factors in the retailer's choice between foreign and domestic manufacturers? Three, what market segments have the domestic manufacturers been most successful in? And, four, what is the impact of the size of a firm on productivity and profits?

A. What Does the Customer Want From a Resource?

In essentially all cases the retailer wants to fill a line in a specific price range. Therefore the initial requirement is being presented with a sample which may be sold in the right range. Taking this as a starting point, there are a number of items considered by the retail buyer. These do not lend themselves to a priority ranking as all are considered: some with perhaps more weight than others, but it is the sum of all factors that counts in the final decision.

Given this preamble, the retailer is concerned about style, about delivery or timeliness, both on the original order and on subsequent reorders. In particular, the manufacturer who will stock inventory is perferred. (The risk of carrying a style in inventory implies a style volume and number of customers for that style which many manufacturers do not have.) Closely related to timeliness is reliability or dependability. In other words, can the manufacturer be counted on to keep the retailer informed as to when he is going to get his order and any problems that may have occurred. This, of course, is related to customer service and to taking care of problems that may arise before the order is delivered or after the order have been received. And, again, this in turn relates to quality control; making sure that the delivered goods match the sample that the retailer made his original decision on. Finally, the retailer looks at the capacity of the manufacturer. This is critical to the retailer because he wants to be sure that the manufacturer will have enough flexibility to be able to deliver the order on schedule and with the proper quality. For example, one major retailer normally will not deal with a resource whose overall capacity is less than 1500 pairs per day. They prefer manufacturers in the 5000 pair per day range or larger.

In summary, the retailer chooses a resource in a specific price range on the combined basis of:

- Style
- Delivery-timeliness-inventory
- Reliability-dependability
- Customer service
- Quality control
- Manufacturing capacity

B. What Factors Influence the Retailer in Choosing Between a Domestic or a Foreign Manufacturer?

It is difficult to generalize about the factors influencing the import decision because you can easily find a dozen examples, which will give you a response which is opposite to whatever you have stated. Nevertheless, in general, there appear to be several factors which tend to favor imports and several factors that tend to favor the domestic manufacturer.

Of those factors favoring imports the obvious one is price. The margins available to the retailer using imported shoes is inevitably better across the board although in some price ranges from countries the gap is narrowing. The second factor which tends to favor imports is style and quality. Again, this will vary with different lines and price levels. Another factor is simply that in some cases a buyer is not able to obtain a specialty domestically. For example, some types of clogs and sandals, as well as some types of handwork or leathers are not available from U.S. manufacturers.

On the other hand, there are certain factors that, in a very general way tend to favor the domestic manufacturer. These factors are:

- Customer services (which relates to returns, repairs to factory-damaged shoes, etc.,)
- Reorder flexibility,
- Inventory,
- Delayed billings,
- And propinquity (when you want to drop in on a resource and find what is really going on with your order).

C. What Market Segments Have Domestic Manufacturers Been Most Successful in Resisting Import Penetration?

Information provided to the U.S. International Trade Commission by importers provides an interesting pattern of penetration of the U.S. footwear industry. Table 1 categorizes the industry by type of footwear and price class. Each category lists the percent of penetration by foreign competition. The table quantifies in detail what people have been making generalizations about, such as, "Imports completely dominate the low price end of the business."

With imports as a percentage of total sales tending to level off the past few years, we could assume that indicates the "easiest plums" have been picked. In other words, foreign manufacturers may have exploited

Table 1

IMPORTS' SHARE OF THE U.S.

FOOTWEAR MARKET BY PRICE CLASS[1/]

(1974)

TYPE OF FOOTWEAR	LOWEST PRICE CLASS	MIDDLE PRICE CLASS	HIGHEST PRICE CLASS	TOTAL CONSUMPTION
Men's Dress and Casual Shoes	47.2	26.6	40.1	33.1
Men's Boots	47.1	13.8	22.4	25.2
Men's Work Shoes	71.4	4.8	4.5	21.0
Youths' and Boys Shoes	53.1	10.0	3.6	27.9
Women's Flat Shoes	79.1	16.2	16.9	18.7
Women's Boots	79.2	59.1	67.9	56.6
Women's Shoes, 8/8 inch & up	79.9	36.7	55.2	51.4
Misses' Shoes	66.7	23.4	17.6	44.0
Children's Shoes	53.1	10.0	35.7	31.9
Infants' and Babies' Shoes	26.0	10.9	11.9	17.2
Slippers	74.0	26.8	10.0	23.7

1/ "The Nonrubber Footwear Industry: A Summary of Recent Industry Trends," Department of Commerce, circa, 1977.

their obvious advantages, and our weaknesses, fairly completely at this point and appear to have reached a plateau. If this is so, further significant encroachment will only be the result of head-to-head competition with our strengths.

For the sake of ease in evaluating the pattern of import penetration we have utilized an arbitrary 30 percent as the breakeven point in determining a market segments' high resistence to penetration.

Utilizing this premise the low price market segment in all but Infants and Babies Shoes is under heavy competitive pressure. Women's Boots and Women's Shoes 8/8 Inch and Up in <u>all</u> price categories are also under very heavy pressure. Going from these striking examples of penetration to other types of footwear yields less decisive statements. However, it can be seen that in all other types the domestic manufacturer dominates the middle price class. The high price is also dominated by the U.S. manufacturer except in Men's Dress and Casual and in Childrens.

It would appear from the foregoing that there is considerable amount of business that the U.S. manufacturer has a very good lock on. Further, there is reason to believe that if he maintains his competitiveness he can probably prevent any appreciable amount of erosion in the future in the market segments he now dominates.

D. <u>Impact of Firm Size on Productivity and Profits</u>

A striking fact about the U.S. footwear industry is the correlation between the size of the firm and profits. This relationship is not uncommon in other industries but the spread between the smallest and the largest is dramatic in the footwear industry. Table 2 displays the experience of various sized producers of footwear with profits from their shoemaking operations only.

Table 2

PROFIT EXPERIENCE FOR PRODUCERS OF FOOTWEAR OPERATIONS ONLY

FOR SIX MONTH PERIOD, 1976 2/

	<200	200-500	500-1000	1000-2000	2000-4000	>4000
Net Sales	17,633	74,742	206,341	112,333	384,446	785,000
Cost of Sales	77.6%	81.6%	77.9%	76.4%	74.0%	72.2%
Gross Profit	22.4%	18.4%	22.1%	23.6%	25.2%	27.8%
Selling, Administrative and General Expenses	19.6%	14.2%	17.3%	17.3%	18.0%	19.5%
Net Operating Profit (or loss)	2.8%	4.2%	4.8%	6.4%	7.2%	8.2%

2/ Footwear Manual 1977, American Footwear Industries Association, Arlington, Va., p. 293.

Note in particular the cost of goods sold (cost of sales) as a percentage of net sales. With the exception of the smallest firms, cost of goods sold (CGS) goes down as the size of the firm's output goes up, ranging from 81.6% in the 200,000-500,000 annual pairs category steadily down to 72.2% in the over four million pair category. The improved CGS is undoubtably related to the higher volume and longer production runs which in turn provide the opportunity for using new technology and fewer setups to increase productivity High volume and associated financial strength makes possible savings in the purchase of raw materials and components. Further, larger volume business makes possible the use of improved management information systems for: production planning and control; labor, equipment and material scheduling and loading; purchasing and inventory control; quality control; and job status reporting.

Another interesting item, in reviewing Table 2 is the trend in selling, administrative and general expense (SA&G). SA&G moves exactly opposite to CGS as the size of the firm increases, again, with the exception of the smallest manufacturers. The inference we draw from this trend, that is, to increase as the size of the firm increases, is that there is a greater appreciation by the larger firm of the necessity for marketing. By marketing we include style development, sample programs, representation at shows, sales and salesmen support, inventory distribution and warehousing. As so aptly pointed out in a companion report, by Charles W. O'Conor and Associates, the shoe retailing business has undergone major structural changes coincident to the rise in imports. Some shoe manufacturers, busy fighting the obvious threat of foreign imports, have overlooked the change in the way retailers are doing business. With the growth of large chains of retail outlets, no longer regional but spanning the country, merchandizing has changed and, necessarily, so have the procurement practices of the volume retailers who now dominate the industry. Marketing the volume retail houses is now a much tougher, much more competitive job, but the rewards can be great for those manufacturers who can first perceive and then meet their increasing needs.

One last element of size is worth mentioning. This concerns the appropriate size of firms required to adequately handle a house line of branded shoes. The same phenomenon which has revolutionized the local and regional retail markets for shoes understandably has an impact on the marketing of brand shoes by manufacturers. A consequence is that the regional market, served by regional promotional activities, has become a national market. A brand now must compete nationally against well financed and aggressive retailer brands.

According to some industry experts the result is that a brand must obably do at least 10 million dollars worth of business, or in round numbers million pairs per year, in order to have the financial wherewithal to pport the kind of promotional effort necessary. Without heavy national omotion to develop a customer franchise for the brand, the line is doomed eventual failure.

The question, then, of course, is how well can the U.S. footwear nufacturer maintain or increase his competitive stance? That is the subject the next section.

III. A Strategy for Increasing Competitiveness

In this portion of the report we will recap what the business environment appears to be demanding of the footwear manufacturer if he is to stay competitive and profitable. We will then describe the concept of a cooperative manufacturer's enterprise which has been the potential of meeting many of the environment's demands. Finally we will describe ways the cooperative concept can be applied to the footwear industry to obtain a better position in the marketplace and reduce the cost of goods sold.

A. Demands From the Business Environment

From our discussion above, manufacturers who wish to meet the increased competitiveness that pervades the industry as the result of imports and changes in the retail end of the business, must, from a marketing standpoint, be able to:

- Bring marketable styles to the retailer.
- Deliver the desired quantities on time and fill reorders expeditiously, and most desirously out of inventory.
- Convince the retailer of the manufacturer's reliability and dependability to accomplish the above.
- Provide customer service to keep the retailer informed of the status of orders and to solve any problems arising before or after delivery of the orders.
- Maintain the level of quality originally sold and keep returns and factory damage at an acceptable minimum.
- Have enough manufacturing capacity so that the retailer will be satisfied that there is enough flexibility in the operation to handle the order. (This has been estimated to be in excess of one million pairs per year.)
- Have enough capacity so that production for a single retail customer never exceeds 50% of capacity.

Further, in terms of which market segments have the best chance of continued success in resisting import penetration, it appears that the low price ranges are very good prospects. Similarly, Women's Boots and Women's Heals 8/8 Inch and Up are difficult areas to compete in except for some specialty and high style firms. Clearly the middle price range markets are where the domestic manufacturers strengths lie. It is in these areas that the coming battles with imported goods should be fought. This is not to say that domestic manufacturers should abandon any market segment where they are currently successful -- far from it. On the other hand, manufacturers now struggling in those segments under heavy pressure might do well to retreat to more favorable ground.

All of this means a major improvement in marketing strategies and marketing abilities. It means getting the styles that will sell in front of the volume retailer on a basis that at least equals existing large volume manufacturer competition.

On the other hand the manufacturers must improve the efficiency of operations in order to keep product costs within the price ranges required. To this end, the advantages of size are obvious. This is not to say that small manufacturers cannot be very profitable, some are. But taken as a group, the smaller firms are less efficient and less profitable. Therefore, the best way for the footwear manufacturers to meet the increasing competition is to become larger, more efficient and ultimately more profitable. The question is how to accomplish this without losing the diversity and entrepreneurial skills which have given the footwear industry such character over the years.

In the next section we hope to answer this question by describing a concept which can achieve the marketing and operating requirements demanded by the business environment.

B. The Cooperative Manufacturers Enterprise Concept

At the turn of the century the independent farmer found himself increasingly at the mercy of the large volume wholesalers and retailers. To quote Professor Martin A. Abrahamsen, an authority on agricultural cooperatives:

> "Cooperatives make it possible for their members to negotiate with large multibillion-dollar corporations on a more nearly equal basis rather than perpetuate a situation where individual farmers continue to compete against one another in selling their products or purchasing supplies and services. Obviously, the individual farmer cannot possibly compete with chain stores, implement dealers, or large fertilizer companies on anything approaching an equal basis. To put this another way, cooperatives may be the effective way for members to achieve the economic power they need to prevent their exploitation by a limited number of dominant firms that characterize the oligopolistic situation that has developed in many industries." 1/

Certainly few would argue that the trend in the footwear industry is toward fewer but larger and more powerful firms both in retailing and in manufacturing. How can the smaller manufacturers continue to compete effectively under these conditions? The farmers think they have found the answer having established over 9000 marketing and purchasing cooperatives by the mid 1960's.

1/ Martin A. Abrhamsen, Cooperative Business Enterprise, McGraw-Hill, Inc., New York, 1976, p. 204.

Before continuing, a description of what a cooperative business enterprise is would probably be helpful. A useful description follows:

> "A cooperative is a voluntary contractual organization of persons having a mutual ownership interest in providing themselves a needed service(s) on a nonprofit basis. It is usually organized as a legal entity to accomplish an economic objective through joint participation of its members. In a cooperative the investment and operational risks, benefits gained, or losses incurred by its members in proportion to their use of the cooperative's services. A cooperative is democratically controlled by its members on the basis of their status as member-users and not as investors in the capital structure of the cooperative."2/

Using this approach a number of small footwear manufacturers could band together, making available a percentage of their capacity to the coop. Together they could fund the kind of marketing, material and component purchasing which would improve their effectiveness in the marketplace and lower their costs. The larger orders possible would increase production runs and productivity.

To be more specific about the impact of a cooperative on productivity and profitability we will return to Table 2. Discussions with the Anti-trust Division of the Department of Justice about a footwear manufacturer's cooperative indicated that no "large" firms could be a member of such a cooperative. Just what is meant by large firm in the footwear industry is not entirely clear, but for convenience we have put the cut-off at under 2 million pair per year. Using this definition we have aggregated the profitability statistics from Table 2 into two groups in Table 3 -- the large companies, 2 million and greater, and the small companies, everyone under 2 million.

2/ Job K. Savage and David Volkin, Cooperative Criteria, FCS Service Report 71, Farmer Cooperative Service, U.S. Department of Agriculture, Washington, 1965.

Table 3

PROFIT EXPERIENCE OF PRODUCERS OF FOOTWEAR OPERATIONS ONLY

FOR SIX MONTH PERIOD, 1976 3/

(annual production in 1000 of pairs)

	ALL FIRMS <2,000	AS % NET SALES	ALL FIRMS >2,000	AS % NET SALES	DIFFERENCE IN PERCENTAGES
Net Sales	411 345	100%	1,169,496	100%	-------
Cost of Sales	321,272	78.7%	854,472	73,1%	5.1%
Gross Profit	89,773	21.8%	315,024	26.0%	5.1%
Selling, Administration and General Expenses	69,080	16.8%	222,596	19.0%	2.2%
Net Operating Profit (or Loss)	20,693	5.0%	92,378	7.9%	2.9%

3/ Abstracted from Table 2.

The importance of Table 3 is that it indicates the potential, fiscal impact of joining together enough small firms to operate well within the large firm category. For an illustration of this impact we have put together a hypothetical footwear manufacturer's cooperative made up of twenty of the small manufacturers with proportionate membership (6%) from each size category. This grouping of 20 firms would represent a production capacity of approximately 9 million pairs annually or very near the 10.6 million which represented the average size of the producers in the over 4 million pair category in 1974.

Assuming a full line, $7.45/pair (average, 1976) and utilization of 50% of the members' capacity for coop business the revenues would be $33,500,000. The coop income statement would look like this:

Net Sales	$33,500,000
Cost of Goods Sold	24,489,000
Gross Margin	9,012,000
Selling, Administrative, and General Expense	6,365,000
Net Profit	2,647,000

Recalling from Table 2 that the S,A&G was 2.2% higher in a larger operation, the additional expense in this area is $737,000. Theoretically, this expense is the additional amount spent by the coop for increased marketing in contrast to the membership's usual SA&G expenses. In a sense you could say that this is the additional expense required to operate like a large firm.

Offsetting the increased SA&G are, of course, the coop's operating efficiencies represented by a 5.1% decrease in the cost of goods sold. In our example this would be $1,709,000. The difference between the S,A&G and the CGS decrease is $972,000 which is, of course, the increased net profit due to moving from small operations to large scale operations.

The above example assumes that no new business was generated as a consequence of the cooperative but simply that more effective marketing and operations resulted from larger orders and improved material purchasing.

We now turn to some of the specific benefits a cooperative could yield in the marketplace and in operations.

C. Better Position in Marketplace

The cooperative effort could provide for improved marketing services. This could take place in three areas. Styling, of course, is the predominant area. Activities could include the possible integration of coop

The cooperative enterprise could help in the area of customer service and by providing distribution services, as well as quality control, inventor and warehousing functions. In the area of reliability, it would have the strength of a much larger organization in terms of lending credibility to statements about timeliness of deliveries, returns and rework and the genera fiscal stability of the organization. The size of the organization would give the retailers confidence that there was enough manufacturing flexibilit so that, should a serious problem develop in a particular manufacturing facility, it could be met with assistance from other locations.

Lastly, the longer runs will enable the coop salesman to remain competitive by staying with the desired price range for a line.

D. <u>More Efficient Operations</u>

More efficient operations are possible through cooperative effort. With better marketing larger orders would result in longer production runs which would be assigned to appropriate coop members. This of course would result in improved labor productivity with fewer setups. It would also result in lower raw material costs stemming from the ability to make larger buys of raw materials and with improved financial circumstances to be able hedge in areas where raw material prices are fluctuating.

The coop enterprise makes it possible to get into the area of component buying or even manufacturing, where it seems appropriate. Along these lines it would be possible to setup a system to use a variety of specialists whether they be in stitching contractors, pattern grading services, etc.

The cooperative approach provides the opportunity to try out new and better technology with the longer runs and with the opportunities to experiment by sharing the burden among a number of manufacturers rather than having one try to do it himself.

The coop would provide management information system capability since the fixed costs of such systems can be spread over the large number of members. This will make it possible for smaller operations to enjoy the benefits of, for instance, measuring labor productivity on a day-to-day basis, shop loading, job dispatching, labor work scheduling, material requirements, planning including raw and in process inventory control, and job status.

In the next section we describe the actions required by industry and government to effectuate the strategy outline above. As with the rest of this report, the specific list of activities outlined are not meant to be exhaustive, hopefully include all the critical ones.

IV. What Industry Needs To Do

The ball is really in industries court insofar as making the first move in implementing the cooperative strategy. Before the government can help, assuming such help may be needed, a lot of spade work needs to be done. For example, what kind of coop makes sense? What type of manufacturers should belong? What does the business plan look like? What are the fiscal requirements? And finally, how should the coop and business plan be funded? These questions are addressed next.

A. Form a Working Group

The first step is form a working group of interested manufacturers of the appropriate size. A very broad group of manufacturers, in terms of size and market segment coverage, would probably be desirable initially. Further discussions with the Anti-trust Division of the Department of Justice may help fix what the upper size limit should be. This second step will help refine the working group membership although, except for the size of firm limitations, a diverse group should be maintained at least through the next step.

B. Determine the Nature and Objective of the Cooperative

The second step is to determine the nature and objectives of the coop. For example, will it be a marketing enterprise only? If so, will it represent all types of footwear and all price ranges? (From the discussion on the business environment it would seem sensible to push shoes in the low price range. On the other hand, perhaps the coop will want to go with a full line and import shoes to fill certain market segments!) Should there be a coop branded line?

A second possibility, rather than a marketing coop, would be to become a purchasing coop. In this case, the decisions required would deal with whether or not to buy raw material, and whether or not to inventory it. Other questions revolve around: component purchasing, or even manufacture; component importing; and possibly even finished goods in importing, acting in the role of import agent.

A third possibility in forming a coop would be some combination of marketing and purchasing enterprise combining some or all of the elements above.

Lastly, the coop could be planned to go the whole route of vertical integration, going all the way from raw materials acquisition through components, manufacturing, and branded marketing to the establishment of coop retail outlets. Without doubt this last possibility is not a practical option in a start up situation. However, the eventual possibility is there and is fun to speculate about.

C. <u>Identify and Solicit Potential Members</u>

The third step, after having decided upon the nature and objectives of the coop, is to identify the manufacturers whose operations match the coop's objectives. It would be desirable to solicit all those serving a choosen market segment to join in the venture, limited of course by their size. In order to proceed to the next step, development of a business plan, it is necessary to obtain at least a tentative agreement from prospective members to join in the enterprise.

D. Develop Business Plan

The fourth step is development of a business plan covering a one to three year period. This should include:

1. The market/purchasing plan for the period listing expected sales revenues/material costs.

2. Estimate the administrative organization required to staff the coop's activities.

3. Estimate the fiscal requirements for marketing, purchasing, customer service, quality control and general administration, including the management information system.

4. Estimate capital requirements for working capital, finished goods, in process, and raw material inventories, warehousing and other required facilities.

5. Estimate expenses and capital requirements for new technology experimentation.

E. Establish Funding Method And Plan

Next, establish the funding requirements to implement the business plan. This is a critical area in the formation of a cooperative. Over the past fifty years a variety of schemes have been tried. The most effective means of funding is the so called revolving finance method. Even here there are many variations in use as the membership of different cooperatives have sought ways to best serve their purposes and financial circumstances. In any event, the following quote, by two authorities in the field provides a succinct description of the concept:

- "The general term 'revolving plan' is applied to a variety of arrangements whereby a cooperative association may raise capital continuously in some relationship to membership participation by withholding funds from members and whereby the older funds are returned periodically and systematically in the order they were withheld to the contributors of an earlier period."3/

3/ H. E. Erdman & G. H. Larsen, Revolving Finance in Agricultural Cooperatives, Mimir Publishers, Madison, Wisc., 1965, p. 69

Revolving fund plans may be provided for either the capital stock or the nonstock type of association. The procedures for attaining these ends as found in practice vary in their details in confused profusion. Funds are obtained most commonly from three sources: (1) at the start by subscription to a capital fund with an understanding that this fund shall be the first to be paid off once the revolving process is under way; (2) withholding specified amounts or percentages from proceeds of sales - for example 5¢ per dozen shoes, $1.80 per case, 1 percent of sales, etc., and (3) by withholding some portions of the savings which are ultimately to be distributed as membership dividends.

Of course, the capital structure of a coop is not made up entirely from equity contributions from its members, far from it. Debt financing is normally provided through three types of loans:

(a) Facility loans, normally available covering 60 to 75 percent of the market value of the property.

(b) Operating capital loans -- funds needed to meet payrolls, obtain supplies, pay taxes, etc. -- are normally available up to four times the coop's equity.

(c) Receivables factoring and raw material inventory loans are usually available at 75 to 90 percent of the market value.

Given the extent of financial weakness in much of the footwear industry, the working group may find that it is not possible to raise enough equity capital from the membership and debt from the financial institutions to meet the fiscal requirements of the business plan. At this point the Government's commitment to this strategy will be tested. The Government role in this strategy is described next.

V. What Government Needs To Do

The Government's role in this strategy is certainly important and may be absolutely vital in making success possible. The magnitude of the change required to make the strategy work should make it obvious that it will not happen without great effort. The Government's encouragement and stimulation of those participating therefore will be an important factor

However, there are two specific issues which may require intervention by the Government to solve. These issues are anti-trust legislation and financial support. We deal with these below.

A. Anti-trust Legislation

Discussions with the Anti-trust Division of the Department of Justice concerning the formation of a footwear manufacturer's cooperative were predictably equivocal. The Division representative suggested that any such proposed agreement be filed for review by the Division prior to implementation. The normal fashion would be to go to the Business Review Procedures (BRP) route wherein the firms contemplating a cooperative arrangement submit their intention to the Department prior to taking any official action.

In any event, the law covering the formation of cooperatives, as long as the members don't engage in setting prices, appears to be fairly gray. As a consequence, any proposed cooperative enterprise would have several avenues to explore in reaching their goal. One, of course, is getting the approval of the Department of Justice via the BRP. The second is to take an adverse Justice Department decision to court. The third would be to seek an exemption to existing anti-trust legislation to make cooperatives in the ootwear specifically legal. This latter course of action has a direct nalogy to the agricultural situation mentioned earlier. Following the obbying efforts of the farm block and the Department of Agriculture, the apper-Volstead Act was passed into law in 1922. This act provided a road exemption which enabled the farmers to operate cooperatives without eing in conflict with the anti-trust laws.

Should the Justice Department take a dim view of footwear cooperatives, he Executive Branch should try to obtain exempting legislation if it upports this strategy for increasing competitiveness in the footwear ndustry.

. <u>Financial Support</u>

Should the business plans developed by prospective footwear cooperatives equire more capital to get started than can be acquired from their members nd from lending institutions, it will be necessary to obtain financial upport from the Government. This support could take several forms such as oan guarantees, or taking an equity position in the cooperative (which under he revolving finance plan would be liquidated in several years if there eren't reinvestment by the Government).

The important thing is that the Government become committed to this strategy. With that commitment many of the problems discussed may not even rise. Lacking this support there is little chance that the cooperative pproach to increasing the competitive position of the U.S. footwear industy ill succeed.

VI. Summary and Conclusions

Imports have heightened the level of competitiveness in the footwear industry. Several market segments have been particularly susceptible to import penetration, i.e., virtually all of the low price market and all of womens shoes, except flats. The rate of import encroachment is slackening as the foreign manufacturers have exploited U.S. weaknesses in these market segments. From now on imports must compete against the strengths in the U.S. market.

Concomitantly, footwear retailing has evolved from a local and regional affair into very large volume national chains. Accordingly, marketing has become increasingly sophisticated and the demands on manufacturers, for performance and service, far more intense.

Considering the above factors, along with the pronounced phenomenon in footwear manufacturing of dramatic increases in profitability with increased firm size, the cooperative concept is suggested, providing increased marketing power, productivity, and profit to the smaller firms in the industry. A cooperative association of footwear manufacturers can increase productivity and profitability by providing a highly skilled marketing staff, brand promotion where appropriate, management information systems for production planning and control, inventories and distribution facilities, quality control, increased buying power for raw material and component purchasing and the resources for new technology experimentation.

To be effective the cooperative enterprise must acquire first rate management, management information systems and financial support. But to be successful, industry must have enough interest to actively participate in the formation of working groups and in the critical organizational activities outlined in the report.

Government help may be required in supporting legislation to exempt the smaller footwear manufacturers from some part of the anti-trust laws. Government support may also be necessary in providing for those financial requirements which cannot be assumed initially by industry.

Most importantly the dialogue begun between the footwear industry and Government must be continued so that both may learn more about how the other works. Without this continuing dialogue requests for help from industry will not be fully understood and the response from Government, albeit well meaning, will be less useful than it need be.

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The Footwear Technology Symposium, hosted by the National ı of Standards, was held in Gaithersburg, Maryland on June 1 and 2, 1978. Approx-ly 220 people participated representing the manufacturing, supplier and retailing nts of the footwear industry, as well as federal officials concerned with assis- to the industry. The objective of this symposium was to assess manufacturing ologies which could be adapted or developed to provide a competitive advantage for .S. footwear industry, and to develop a specific plan for activities that would be priate for government and industry cooperation. The meeting was part of a three-Department of Commerce Program to help restore the growth and vitality of the tic footwear industry. Initial sessions presented technical and evaluative infor-n as an input to the subsequent working group discussions of footwear industry sentatives. Government staff described the results of their assessment of the ems and opportunities of the industry. To stimulate constructive dialogue, five te research organizations presented ideas and recommendations for future footwear ological development resulting from Commerce Department sponsored studies. The new technologies and processes presented addressed materials development, leather ologies, customfitting and computer assistance in shoe design and manufacture CAM). In other presentations, the President of the American Footwear Industry iation shared his concerns, a leading footwear designer explored design, marketing he technology interfaces, and representatives of technologically (continued)

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ter-aided design and manufacture (CAD/CAM); footwear industry; fragmented tries; government-industry cooperation; imports; innovation; leather; materials opment; manufacturing technology; shoes; technology transfer

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advanced industries, (aerospace, automobiles, communications) shared their views on manufacturing technologies and applications to footwear industry problems. Preliminary symposium results were evidence of industry enthusiam and support for government-industry cooperative activities, interest in establishing a footwear center to provide industry-wide technical assistance, and a desire to assess computer-aided design and manufacture (CAD/CAM). Reports by the consulting firms on new technologies and business strategies for the footwear industry are included as appendices.

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