

NBSIR 73-288

# Swiss Building and Housing Research Activities

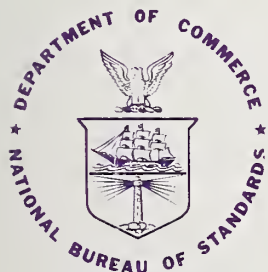
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H. R. Trechsel

Center for Building Technology  
Institute for Applied Technology  
National Bureau of Standards  
Washington, D. C. 20234

August 1973

Final



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U. S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS



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**NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director**



## PREFACE

Although international cooperation is well established in most areas of traditional sciences, such cooperation in the field of building technology was organized only recently beyond occasional and uncoordinated study trips and participation in international conferences. To date, the Center for Building Technology has established formal cooperative research programs with England, France, and Japan. These programs have so far proven mutually advantageous and an expansion of this type of activity appears justified.

This report discusses the results of meetings held in Switzerland with the objective to identify various Swiss building research organizations and to survey building research activities. Based on these results and on further discussions with Swiss authorities during their planned visit to CBT, the possibility and nature of a cooperative program with Switzerland will be considered.

The author wishes to acknowledge the most cordial reception he received from all the Swiss organizations and their representatives. In particular, the help and assistance of Professor J. W. Huber, President, and Dr. G. Koehn, Secretary, of the Swiss Federal Commission for Housing Research (FKW) and of Dr. G. Grin, Science Counselor at the Swiss Embassy in Washington, D. C., is greatly appreciated. It was only thanks to the combined efforts of all the Swiss authorities involved that the visit was not only professionally successful, but also personally rewarding.

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# SWISS BUILDING AND HOUSING RESEARCH ACTIVITIES

Heinz R. Trechsel

Following up earlier contacts of Center for Building Technology (CBT) management with representatives of Swiss building research organizations, the author visited Switzerland in the Fall of 1972 for two weeks.

This report discusses the results of meetings with representatives of the Swiss Federal Commission for Housing Research (FKW), major educational and research establishments, architects, contractors, builders, and local building officials. Topics covered in the discussions included building economics, modular coordination, pre-evaluation of performance of housing projects, pre-evaluation of research projects, building design, land use and planning, transportation, and building laws, codes, and standards.

It appears that cooperative programs in any or all of these areas could be profitable to the National Bureau of Standards (NBS), and to the corresponding Swiss organizations.

Key words: Building research; buildings; cooperation; housing; international; Switzerland.

## 1. INTRODUCTION

As a result of a suggestion by the Embassy of Switzerland in Washington, D. C. Dr. J. R. Wright, then Director of the Building Research Division, Institute for Applied Technology (IAT), NBS, visited Switzerland in 1970 for a two-day study of Swiss building research activities. Dr. Wright found that sufficient areas of mutual interest exist to justify the establishment of a cooperative effort in building research between NBS and appropriate Swiss organizations.

In preparation for such a cooperative program, the author followed up Dr. Wright's visit for a two-week in-depth study of Swiss organizations and programs relevant to building research; met with various organizations and individuals, and assembled information and data on building and housing research activities. The program for the visit was developed by Professor J. W. Huber, President of the Swiss Federal Commission for Housing Research. This program included visits to organizations and individuals active in research, planning, education, design, production, testing, and in the building regulatory field.

The primary objective of the visit was to survey the present building research activities and organizations in Switzerland. As a secondary objective, the building and housing construction activity in general was also briefly investigated.

It is planned that this investigator's visit to Switzerland be followed by a visit of a representative of the Swiss building and housing research establishment to NBS. At that time, the details and scope of a cooperative program between appropriate U. S. and Swiss organizations can be developed.

This report is divided into five broad categories:

1. Introduction
2. Building, Research, Regulation, and Education
3. Building Research Organizations
4. Building Research Projects
5. Summary and Discussion

This division necessitated some duplication of information; however, it is believed that this is justified in the interest of greater clarity.

The organizations visited and persons interviewed are principally active or interested in the "software" aspects of housing design, planning, and construction. Since NBS and CBT have interests also in the "hardware" aspects and in building research other than housing, the information gained during the visits was supplemented by studying the literature collected. Although this report still reflects a strong emphasis on those research areas investigated in person to person interviews, the results of the literature survey are also included. It is thus believed that the information presented constitutes an accurate state-of-the-art of Swiss building research activity in 1972.

The itinerary of the visit to Switzerland, the names and addresses of the organizations visited, and the names of the principal contacts are listed in the appendixes on Pages 54 through 58.

This investigator has received many offers for future cooperation. The warm reception received indicates a very broad basis for a cooperative building research effort by appropriate American organizations with Swiss agencies.

## 2. BUILDING, RESEARCH, REGULATION, AND EDUCATION

### 2.1. Building Activity

In any discussion of Swiss building activity it is useful to note the scale of the country. In the following table some comparative statistics are given for reference. The numbers for the U. S. are given in parenthesis.

			<u>Density</u> Population per Square Mile
Population (1970)	6,300,000	(203,000,000)	
Total Area	16,000 M <sup>2</sup>	( 3,500,000)	395 (57.5)
Uninhabitable area	7,100 M <sup>2</sup>	(NA)	0 (NA)
Inhabitable area	8,900 M <sup>2</sup>	(NA)	710 (NA)

NA - Not available or not comparable.

M<sup>2</sup> - Square Mile

(Uninhabitable areas include lakes, rivers, glaciers, deserts, and other areas only seasonally inhabited.)

The current building activity is under the influence of three major factors:

- continued high demand
- shortage of land
- shortage of labor

The combined result of these factors are strong inflationary pressures; in 1972, building costs are reported to have increased at a rate of approximately 10 percent per annum, and predictions for 1973 run as high as 15 percent.

The high demand has taken its beginning with the end of World War II, during which building construction had been all but halted. General post-war affluence, the drop in average household size (from 4 to 2.5 within 25 years), and increase in population of almost 50 percent over the last 25 years have all contributed to maintain a high demand for new housing despite very high building activity in the past years.

Not only is Switzerland one of the most densely populated countries in Europe, but also large areas are unsuitable for development. Furthermore, the country is pursuing a deliberate policy to maintain a viable agricultural base, both for socio-political and for defense reasons, and various means have been used in the past to discourage the conversion of agricultural land into other uses, such as housing. Legislation now in preparation attempts to regulate future land use on the federal level to prevent land speculation and to make available suitable development land for the orderly growth required.

Up to the mid-1960's almost unlimited immigration of foreign labor was encouraged to ease the shortage of labor. Since then, some restrictions were put into effect. Although the most obvious shortage is in production labor, similar shortages are to be found in the entire construction industry, including drafting, design, and supervisory personnel. The acuteness of the labor shortage can be judged by the fact that most efforts in the area of building research appear not so much directed towards total cost savings, but towards construction labor savings on the one hand, and the increase of the "livability" or "quality" on the other.

Although it is difficult to generalize, the cost level of housing construction can be measured by the following average unit cost figures:

(1) Average housing unit costs are the equivalent of approximately \$80,000. In terms of income, the cost of a housing unit is considered "normal" if it is in the range of 5 to 6 times the annual salary. Developed land for residential construction (suburban location) costs approximately SFR 300 per square meter or \$400,000 per acre; building construction cost averages SFR 300 per cubic meter or approximately \$80 per square foot.

(2) Rental costs, on the other hand, are more similar to American conditions in metropolitan areas: approximately \$200 per month per living unit or 20 percent of salary.

From these figures it is obvious that home ownership in Switzerland is a luxury enjoyed only by those with above average incomes.

The various authorities interviewed appeared to agree that, barring a major economic recession or some serious political problems, the inflationary pressures in the construction sector are expected to continue. However, two developments are looked to for some prospect of relief:

(1) A substantial increase in productivity due to the possible success of present and future building research activities.

(2) The anticipated limited cooperation between Switzerland and the European Economic Community (EEC) which would open up the Swiss construction market to foreign contractors. It is expected that the advent of foreign competition would greatly influence the construction industry. This view was, interestingly, expressed by contracting industry representatives.

To this observer who had not been in close contact with the Swiss building construction industry for some twenty years, the most impressive change was in the scale of housing projects. Not only have high-rise structures (10 stories and up) gained full acceptance, but the size of single housing projects today are often very substantial. For example, in the City of Bern, with a total population of only approximately 165,000, single housing developments of up to 3000 units have been constructed recently. Although developments of this scale are not unusual in the U. S., they are only to be found within the major metropolitan areas.

Another major aspect is the very extensive planning activity associated with these projects. The integration of the required infrastructure (schools, kindergartens, shopping, and recreational facilities) seems to be successful and a direct result of the apparently close cooperation of the public and private sectors during all stages of design and construction.

A discussion of Swiss building activity would be incomplete without the mention of the position of the architect in the process of building construction, and of the method of contract administration. Although the most important activity of the architect is of course the development of building designs and the preparation of contract documents, the architect is generally also responsible for the construction administration and site supervision. Generally, separate contracts are let for each trade, the number of contracts usually being approximately 20, but not infrequently being as high as 50 in large and complex projects. The contracts normally are not based on a lump sum, but on unit prices for specific positions, such as, for example, a square meter of flooring, or a line foot of electrical conduit. This system has the advantages that (1) quantity surveys have to be made only once and by the architect, reducing the contractor's overhead since he is not required to perform this task, and (2) bidding can take place before a complete set of contract documents is available, since minor changes in dimensions are not changing the basic contract provisions (although they do affect, of course, the final cost to the owner). The disadvantages of this system of bidding appear to be (1) the need to determine, usually by on-site quantity survey after construction, the actual quantities provided by the contractor, and (2) the fact that final construction cost are not known until after construction is completed and surveyed. The system is similar to the modern U. S. concept of construction management, but it is interesting to note that at the same time construction management is becoming more widely used in this country, the concept of general contracting is finding growing application in Switzerland.

## 2.2. Organization of Building Research

It appears that in Switzerland the terms "building" or "housing" research always means those research activities which are exclusively related to the building and its use, rather than to the more specific research areas such as structural design or strength of materials; such research being applicable also to structures other than buildings. Although an effort was made to collect some data on these other research areas, this investigator's contacts all were in the area of building and housing research as defined by Swiss usage. Accordingly, the chart shown in Figure 1 shows only the organization as it affects housing research.

The chart shows that all aspects of housing at the federal level are reporting through a "delegate" directly to the Federal Council, the

highest executive body in Switzerland. It further shows that the Federal Commission for Housing Research (FKW) is placed at the same level as the Bureau for Housing Construction which is responsible for all federal subsidy programs and corresponds to HUD in the U. S. The Housing Commission is a third body at this level and is responsible for the political aspects of housing and community development activities.

The Federal Commission for Housing Research (FKW) does not do any research work itself but has substantial funds available for contracting out research projects. The organizations which conduct the research under contract to FKW are many and of varied backgrounds. They include the research institutes attached to both Swiss Federal Institutes of Technology (ETH-Z and ETH-L), private research organizations, practicing architects, and ad-hoc groups formed specially for the duration of a particular research project. This report on Swiss building research activities is based on visits mainly to such research organizations under contract to FKW.

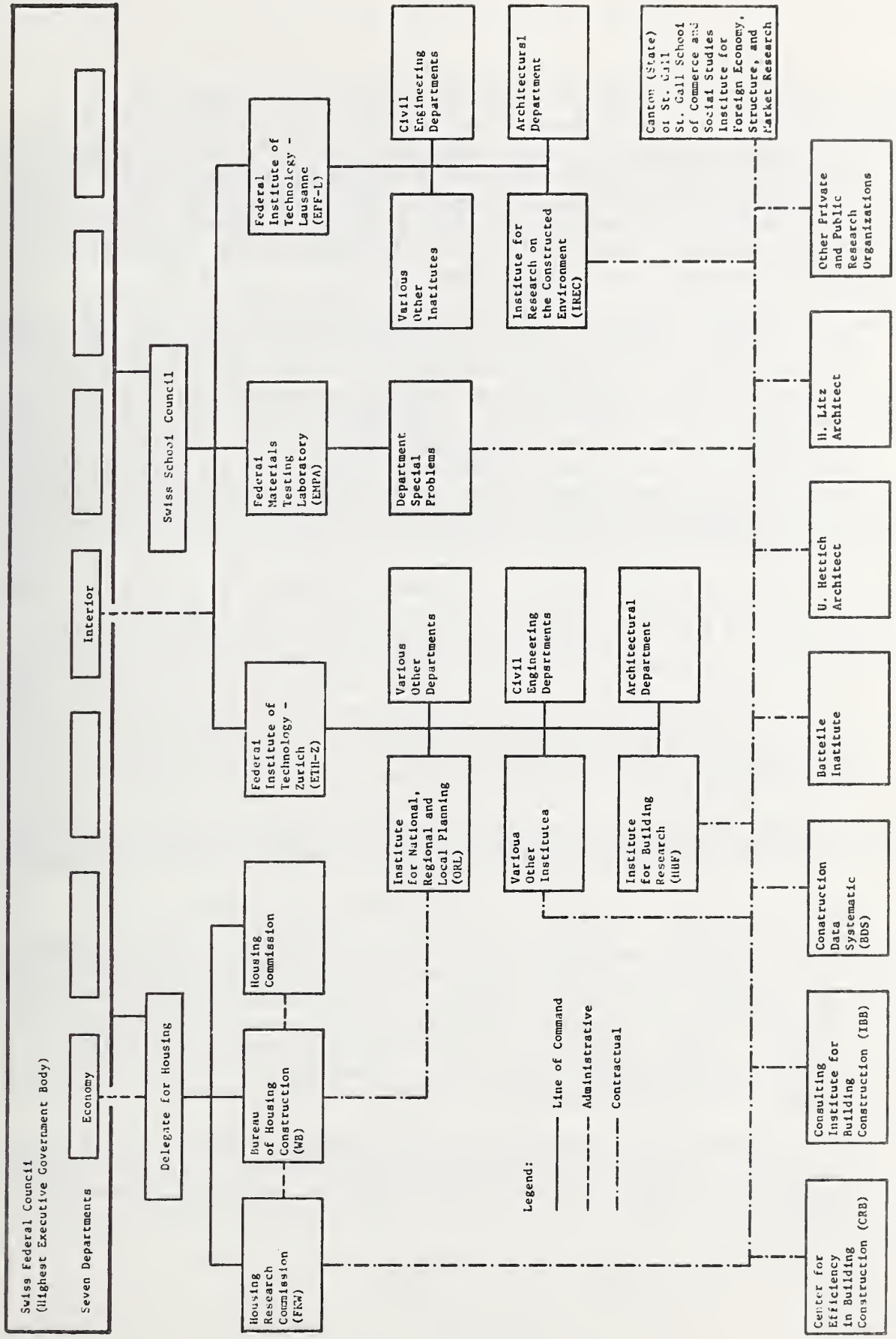


FIGURE 1. ORGANIZATION CHART OF SWISS BUILDING RESEARCH ACTIVITIES

### 2.3. The Building Regulatory System

As was shown above under "Building Activity", the population density on the inhabitable land area of Switzerland is extremely high. This density has led to a building regulatory system concerned not only with the construction features of single buildings, but also with planning aspects and with the relationship of buildings and/or developments to each other and to the general population.

General legal principles in Switzerland appear to hold owner, architect, engineer, and contractor responsible and liable for any building related accident, irrespective of whether or not such accident was caused through the negligence of the owner, architect, etc. So as not to diminish this responsibility, laws, regulations, and codes are held largely in general terms, referring simply to "good engineering practices". Detailed codes would be considered implying at least a partial responsibility by the Government for the performance of individuals connected with building activities. Instead, the Government agencies perform essentially a policing function (they are also called "building police").

Fire protective aspects are considered independent of the building regulatory process. Their regulation differs from state to state and is tied-in with the fire insurance requirements. Unlike the general building regulations, the fire protection aspects are mostly regulated by the canton (state). There do exist "Guidelines" issued by the "Association of Swiss Cantonal Insurance Companies" (Vereinigung der Kantonalen Feuerversicherungen). These "Guidelines" (Wegleitungen) have no legal standing, but are used by many cantonal agencies as a model for their own regulations.

The three political levels: federal, cantonal (state) and county all share in the total building regulatory activity as discussed below.

#### a. Laws, Regulations, and Codes

The federal authority is limited to special aspects of building activities, such as in the areas of: land use, zoning, and building-lines in connection with federal highway construction; promotion of housing construction; and rehabilitation of housing in mountain regions. In addition, federal regulations govern building related activities of civil defense, accident prevention and employment, electrical installations, and water pollution.

Because of the limited authority of federal agencies, the building regulatory activity is concentrated in general in the cantons (states). However, the conditions within the various states vary in three major categories.



A first variation is in the division of the respective responsibilities between canton and county. For example, whereas in the Cantons Basle-Stadt and Geneva, the entire building regulations are handled on the cantonal level, in some of the more rural states cantonal law merely authorizes the counties to regulate building activities within their jurisdictions. Between these two extremes, any division of responsibilities between states and counties can be found.

A second variation exists in the intensity of the regulatory activity. The degree of detail covered by the building regulations varies very substantially between single cantons and between counties, even within the same canton.

Finally, there exist differences in the technical content of building regulations, although such differences do not appear to be as great as could be expected, because for some of the technical aspects the codes, or the norms of the Swiss Engineers and Architects Association (S.I.A.) are generally recognized and are referenced in appropriate sections of the regulations. Also, it is a fairly common practice for counties to seek the advice of the canton in technical matters and this tends to increase the uniformity at least within the canton.

The building regulatory laws can be divided into three parts, related to planning, development, and building construction.

#### b. Planning

In this context, planning is the predetermination of zones for land use including use density. It can be national, regional, cantonal, or communal in scope. Most authority for planning is currently at the cantonal level, although the Federal Government has recently acquired legal means to act in specified planning related questions. Within their jurisdiction, the counties also have some planning authority.

A new federal law enacted on March 17, 1972, as a temporary urgent ordinance, requires the cantons to act in the planning field by excluding certain areas from future development. The criterion for these areas are given in the legislation as follows:

- (1) River banks and lake fronts.
- (2) Landscapes of particular beauty and singularity.
- (3) Cityscapes, villages, historical places, natural and artistic memorials, etc., of national or regional importance.
- (4) Recreational spaces.

(5) Areas which are known to be endangered by natural forces.

While the federal law mandates the cantons to designate areas based on the above criteria, the cantons themselves are responsible for the selection of the areas. Furthermore, the law specifically empowers the cantons to designate additional areas exempted from development if such exemption is needed to safeguard future planning options.

A permanent ordinance relating to planning activities is pending in the legislature. This law is designed to incorporate the provisions of the temporary urgent measures of March, 1972, into the permanent body of law, and to provide the detailed legal basis for an extensive new planning policy. An integral part of the pending legislation is a system for compensating owners of land which can not be developed, and a heavy taxation of profits realized from the sale of land opened for development.

Active both for the Federal Government and for the canton is the "Institut fuer Orts, Regional, und Landesplanung" (ORL). It is this Institute which, under contract and in cooperation with the cantonal governments, will in fact largely select the areas to be "permanently" excluded from further development.

c. Development

The term "development" as used here means all those regulations which deal with the transition from one land-use to another, such as when agricultural land is developed for housing. Included are the laws governing the construction of roads and other items of infrastructure, as well as some aspects of eminent domain and private real-estate property rights. Although federal laws do regulate specific aspects of this area, cantonal laws in general are governing. County authority is limited.

d. Building Construction

This is the area dealing with single building constructions, their parts, and components. Again, the regulation of this area is generally divided among all three authorities: federal, cantonal and local.

The federal activity is limited to certain aspects in the area of housing construction through a form of "minimum and maximum property standards" for subsidized constructions, and in the other areas mentioned earlier. All other aspects are either under cantonal or local jurisdiction as applicable within any specific state.

e. Content

While in the U. S. building regulatory activity traditionally is concerned only with safety to life, health, and property, Swiss building

regulatory concerns include general environmental aspects. Among these are aesthetics and architectural design, protection of significant natural and historical landmarks, provisions for building access by invalids, pollution control, planning and zoning, and requirements for the provision of playgrounds. It is interesting to note that for example the Bernese Cantonal Building Law does not even mention health and safety as related to construction activities, and in the applicable Building Ordinance (or Rules and Regulations) of the same state, construction related building safety, including special provisions for high-rise buildings are contained in only 14 of a total of 61 pages. From the discussions and a study of obtained literature, including a few laws and ordinances, it appears that the Swiss building regulatory activity is largely concerned with areas of direct common or public concern, that is with those aspects which affect the population as a whole and the neighbors, and not primarily with those aspects which affect the safety of the occupants of the buildings.

Although the ordinance mentioned above (for the Canton of Bern) does give some specific requirements (for example, minimum exit widths), such specific requirements are rare. Instead, the ordinance requires that "for all constructions recognized engineering principles must be followed", and refers to guidelines and codes developed and published by such organizations as the Swiss Accident Insurance Association (SUVA), the Swiss Society of Engineers and Architects (SIA), and to other regulations governing specific areas such as electrical and gas installations.

#### f. Enforcement

Three aspects of Swiss building regulation enforcement policy seem interesting and in contrast to U. S. usage.

First, where the cantonal building laws are preemptive (such as in the Canton of Bern), the canton generally delegates the enforcement of its laws and ordinances to the municipalities, maintaining a sort of monitoring activity only. However, the canton may reserve the right to enforce its laws if the municipality does not do so. In such cases, the municipality must reimburse the canton for its activity. In addition to enforcing the cantonal laws and regulations, the municipality and its "building police" may also enforce their own regulations within their jurisdiction, if such local ordinances are mandated by the canton.

Second, "enforcement" of building regulations in Switzerland does not normally include a full plan check and exhaustive inspections. In keeping with general legal principles, the designer, builder, and owner are presumed to follow the regulations and codes, and only spot checks are made by the agency. However, plans must be submitted to the agency for open inspection by the public; and owners of neighboring properties or other interested parties must be advised either by newspaper advertisements or by direct letter of planned constructions. It is then assumed

that the neighbor checks the plans for possible violations to his detriment, and that he notifies the agency accordingly.

Thirdly, by requiring that all work must be performed by licensed contractors, it is believed that a high degree of compliance with the regulations and with the appropriate codes is ensured.

#### g. Responsibility

The regulatory activity was discussed with representatives of city and cantonal agencies. They stated flatly that the responsibility for safe buildings and for meeting the laws, regulations, and codes, rests solely with the owners, designers, and contractors, and that a complete plan check and thorough inspections by the agency or its representative would in fact dilute the owner's responsibility and establish the agency's co-responsibility. As proof of the workability of the Swiss system they cited the fact that failures or serious code related accidents are practically unheard of.

#### h. Evaluation by Architects and Contractors

The general area of codes and regulations was discussed with representatives of contractors, housing producers, and architects. None of them appeared to be overly concerned with the subject, except that they expressed strong support for greater uniformity. Two architects, in answer to a direct question, stated that they could not think of any instance in which codes influenced their designs or constructions, and that the existence of codes does not influence construction costs.

### 2.4. Education

Essentially, there are three educational levels in building construction activities available in Switzerland:

#### a. Draftsmen and Craftsmen

Preparation for these occupations consists of a total of 8 to 10 years of primary or secondary education, an apprenticeship of three to four years, and part-time schooling during the entire apprenticeship. The apprenticeship program is very well organized and institutionalized. The part-time schooling is rigorous and includes both a continuing education in general subjects and specialized training and education. After completion of his apprenticeship a draftsman, mason, carpenter, etc., is expected to essentially know all facets of his trade and in addition to have a reasonable familiarity with related subjects. He is generally at a level where he can be given a task within his field of competency and perform all necessary work without further technical supervision or instruction.

## b. "Techniker"

The literal translation of "technician" does not accurately define this educational level.

In general, a "Techniker" has to have completed a full apprentice program and have some practical experience before entering a so-called "Technikum". The "Technikum" is a cantonal (state) or private three to four year educational institution in which the future "Techniker" is given the full theoretical and practical education to solve all typical engineering problems within his trade area. Public "Technikums" generally are full-time schools, while several private "Technikums" offer part-time evening study programs. Although the degree of "Techniker" is similar to the bachelor degree in America, the training is much more directed toward the practical aspects of a technical specialty, and his general studies are limited. A "Techniker" can not normally enter directly a graduate program at a higher institution of learning. In the field of architecture, many "technikers" have been successful as practicing architects.

"Technikers" are often found in such positions as office chiefs, project managers, and construction superintendents of even large projects. They are employed by small and large contracting firms and by building regulatory agencies. "Technikers", on the other hand, are seldom employed by research organizations.

In recent years "Technikers" are increasingly using the titles "Architect" or "Engineer". This usage is legal and is in line with the terminology used in other European countries.

There does exist today in Switzerland a school for construction superintendents. It is located in Soloturn, but this investigator has had no contact to get additional information, neither in regard to prerequisites nor to curriculum. However, it appears that this school would essentially be at the "Technikum" level.

## c. Architects and Engineers

At the college or university level, the two Federal Institutes of Technology in Zurich (ETH-Z) and Lausanne (EPFL-L) are the only engineering and architecture schools in existence in Switzerland. They both are full-time day schools.

The prerequisite for all courses at these schools is the successful completion of the "gymnasium", a school that branches off from the primary school after the fourth or fifth year, and continues through grade thirteen. The "gymnasium" is strictly a college preparatory school and the final exam is called "Maturitaet" (in the German speaking part) and "Baccalaureate" in the French speaking part of the country.

Both architectural and engineering studies generally follow a "norm study plan" in which few options are open to the student, except in the area of general studies. After generally two preliminary exams, the final exam is called the diploma. This can be followed by graduate studies of generally two years leading to the doctorate. Doctorates in the field of architecture are rare.

The civil engineering area is divided into two separate departments and study fields:

(1) Structural engineering with emphasis on structures, buildings, bridge, and other constructions.

(2) Civil engineering with emphasis on surveying, drainage and irrigation, road and utility construction.

Unlike the education offered in the "Technikums", the college level courses generally stress the theoretical aspects of the profession and the alumni are expected to enter private praxis, research organizations, or management level positions in industry or government after a short period of practical work experience.

So as to differentiate the architect or engineer with a university level education from the "Techniker", the former uses the title "Diplom Architekt" (or engineer). The use of this title is illegal unless the holder has successfully completed all the requirements of an approved university-level school.

### 3. BUILDING RESEARCH ORGANIZATIONS

The term research is used here in its broadest possible sense. Accordingly, the following descriptions include also educational and planning organizations whose activities are related to the total building research effort in Switzerland.

The personal survey of Swiss building research organizations entailed visits to organizations almost exclusively concerned with housing construction, and with only few exceptions concerned primarily with the "software" aspects of building research. So as to present a broader based report on Swiss building research, this investigator has also obtained and studied some written information on additional organizations.

#### 3.1. Forschungskommission Wohnungsbau (FKW) (Federal Commission for Housing Research)

Based on the federal law to promote housing construction, enacted March 19, 1965, by the Swiss Parliament and effective as of March 1, 1966, the Federal Council established the Commission on Housing Research on February 22, 1966. The first members of the Commission were appointed by the Department for Economic Affairs on June 28, 1966.

The Commission constitutes a non-parliamentary Commission reporting administratively to the Department of Economic Affairs. Its objective is the promotion of research to raise the productivity in housing construction. The "raise in productivity" is defined as the improvement of the relation of total effort to total result, whereby the number or amount of housing construction, its quality, and the required operating and maintenance cost must be considered.

In pursuit of its objective, the Commission sponsors housing research by outside persons; the Commission itself does not have the staff or facilities to conduct its own research. Although the regulations require that appropriate research be generally supported with only a 40 percent subsidy, they do permit on exceptions the 100 percent funding of research contracts. In praxis, this exception has become the rule and most contracts are now based on specific requests by the Commission at 100 percent funding.

A research plan and a priority list, both developed by the Commission, guides selection of research project. The plan has eight points:

1. Housing Habits
  - 1.1. Socio-economic conditions
  - 1.2. Housing physiology
2. Financing and Development

3. Real Estate and Infrastructure
4. Housing Design
  - 4.1. Building design
  - 4.2. Building physics
  - 4.3. Mechanical and electrical equipment
  - 4.4. Interior arrangement
  - 4.5. Cost estimates and methods for their determination
  - 4.6. Bidding and contracting
  - 4.7. Construction planning - use of CPM, etc.
5. Building Materials and Components
  - 5.1. Building materials
  - 5.2. Testing of building materials
  - 5.3. Modular coordination and standardization
  - 5.4. Information systems on building materials
6. Building Construction
7. Housing Market
8. Legal Aspects

The original priority list recognizes three categories.

1. For Immediate Development

Projects which promise to result in a substantial increase in productivity in the near future, and projects needed as a basis for future studies.

2. To be Started Before the End of 1970

Projects which also promise to result in a substantial increase in productivity in the near future, but which can not be started immediately because preliminary work must first be completed, or which must be delayed because of lack of personnel or other required resources.

3. For Later Study

- 3.1. Projects which can not be solved with presently available resources.

- 3.2. Projects for which substantial preliminary investigations are required.



3.3. Projects for which legal preconditions are not as yet existing.

As of December 1972, 24 reports based on work sponsored by the Commission have been published either by FKW or by associated organizations. At least five additional reports are available in printed form, and an undisclosed number of reports are in the editorial stages. No information was available on the number of research projects under way, but this number is estimated to be in the neighborhood of 10.

a. Organization of FKW

The Commission consists of its President, Professor J. W. Huber, Architect; two Vice-presidents; and seven members. They represent educational, professional, business, and financial interests involved in housing construction. Through its members the FKW maintains direct contact with the major organizations directly involved with building research and housing policy. For example, Mr. F. X. Suter, First Vice-president, is Chief of the Bureau of Housing Construction.

A Secretariat, under the direction of Dr. G. Koehn, is responsible for all administrative matters, research contract administration, and for the editing and publishing of reports. A technical staff (position of Chief presently vacant) is responsible for technical aspects of preliminary work, monitoring, and technical supervision of research contracts.

According to its current mandate, FKW will be dissolved in the near future; however, under new proposed legislation a permanent organization will not only continue FKW's activity, but will expand its scope to include building research in general. So far as it could be determined, both personnel and organizational structure of the new organization will be identical to, or expanded from, the current FKW.

Unquestionably, the FKW is the central agency in the total Swiss housing research effort. Through its control of all federal subsidies associated with housing research, it is estimated to influence, directly or indirectly, close to 100 percent of such research activity.

3.2. Swiss Federal Institute of Technology -  
Zurich (ETH-Z)

Founded in 1855 as a building trade school, ETH-Z was the first federally funded educational institution. It consists today of eleven departments:

1. Architecture
2. Structural Engineering
- 3a. Mechanical Engineering
- 3b. Electro/Engineering
4. Chemical/Engineering
5. Pharmaceutic
6. Forestry
7. Agriculture
8. Civil Engineering and Surveying
9. Mathematics and Physics
10. Sciences

Directly involved in building construction related activities are the Department of Architecture and Structural Engineering.

A total of approximately 110 institutes and laboratories are either attached to the departments or are directly responsible to the school management. The objective of these institutes is to be active in research, to give technical assistance to industry and all levels of government, and to provide research facilities to both teaching staff and students. Approximately 20 institutes and laboratories are active in fields related to building research in the wider sense, about 10 of which are directly concerned with construction activities.

In 1970, total student enrollment was approximately 6,000 (up from 2,700 in 1955) with a staff of approximately 1,200 professors, lecturers, instructors, and assistants. Projections for 1975 estimate that the number of students will have increased to 7,500. A serious effort is being made to improve the high proportion of students to professors from the current 30 to 1 to 15 to 1 within the next few years.

Physically, the main activity is centered on the campus near the center of the City of Zurich. However, a new campus on the outskirts of the city is under construction. All building related activity will be located at the new facility on the "Hoenggerberg". The school's administration and several of the other departments will remain in the existing campus on Leonhardstrasse.

#### a. Department of Architecture

The formal research work in architecture is conducted at three independent Institutes, the Institute for Building Research, the Institute for Planning, and the Institute for History and Theory of Architecture. The three organizations and their work is discussed in detail below. However, informal research is conducted at the department by study groups consisting of students under the guidance of faculty members. Broadly speaking, these groups are active in three areas:

(1) The development and evaluation of the study plans and the evaluation of student work. This is an effort to find the basis for the restructuring of the education and training of architects. The emphasis in these studies is definitely in the area of social relevance.

(2) Studies related directly to semester projects, the objective being to deepen the student's awareness and understanding of a specific building type, or of a specific planning problem. Basically these are studies in which the program for a project is developed from the standpoint of an interdisciplinary approach.

(3) Studies independent of the other school activities, they include field studies and travel reports, historical studies, and broad research projects dealing with all phases of planning and design.

In all the projects conducted by these study groups the socio-economic aspects appear to be prominent - many projects dealing exclusively in this area, and construction or technology oriented projects appear non-existent. A brief review of a few final reports written by these groups indicated substantial depth as well as a great effort to substantiate findings with detailed statistics.

#### b. Institut fuer Hochbauforschung (HBF), ETH-Z (Institute for Building Research)

HBF is the formal building research organization. Professor Kunz, Director, teaches at the department of architecture major courses in construction supervision and management, building cost, and building construction sequence. The Institute consists of approximately six architects and one civil engineer. In addition, open positions exist currently for one sociologist, one lawyer, one economist and one building cost specialist. In addition, and as required, a part-time staff varying between 5 and 15 professional and clerical persons are employed. The Institute operates under a budget of approximately SFR 1,000,000 (\$300,000) annually. Approximately 10 percent of the budget is used for outside research contracts in specific areas for which required expertise is not available internally.

The Institute does not have any facilities for experimental construction work, although presumably the shops and laboratories of the EMPA could

be used. However, to date, the projects of HBF have been entirely in the area of "software" and no plans appear to exist to expand the scope to "hardware" items.

Project areas of HBF cover the following major areas:

- (1) Building economics, construction cost, and construction accounting procedures, including studies of case histories.
- (2) Design Management, design methodology, and use of network management in the design process.
- (3) Evaluation of quality and performance of housing, including planning, design, construction, and material related factors.
- (4) University planning, an extensive effort at integrating the requirements relating to sociology, education, economy, and construction.

c. Institut fuer Bauplanung und Baubertrieb (IBB)  
(Institute for Construction Research)

IBB is concerned with the construction process as an integrated activity of the major functions of economy, management, and technology, and the minor functions of sociology, law and politics, and ecology. It is a new Institute currently in the formative stage. It is related to the Civil Engineering Department of ETH-Z and it is planned to grow by 1980 to a staff of approximately 70 professional, technical, and clerical employees.

The Institute was established based on the recognition of the gap existing between the purely technically oriented and educated engineer on the one hand, and the entrepreneur-economist on the other. It is the function of the Institute to close this gap by providing education and research facilities to broaden the traditional scope of the civil engineering training which is more concerned with the aspects of design than with those of on-going construction.

Although the Institute does at this time appear to be a functioning organization, no information in regard to specific projects or accomplishments is available as yet.

d. Institut fuer Geschichte und Theorie  
der Architektur (GTA)  
(Institute for History and Theory of Architecture)

The Institute publishes papers on history and theory of architecture. It is also active in the organization of exhibits and administers the school's archives on architectural history.

Of interest is the CIAM archive. The "Congres Internationaux d'Architecture Moderne" was founded in 1928 in La Sarraz. A substantial

number of important CIAM documents on the architecture of the early 20th Century is said to be disbursed among the many nations and it is now intended to collect these documents and maintain them at a special archive within the Institute.

e. Institut fuer Orts-, Regional-und Landesplanung (ORL)  
(Institute for National, Regional, and Local Planning)

The Institute had its beginnings in 1943 as the Center of Planning within the Institute of Geography, and was made an independent institute in 1961. Its responsibilities are in the areas of education, research and consultation and information.

(1) Education

All educational activities are on the graduate level. Prerequisite for entering the two year planning courses are a degree in any of a number of related disciplines, specifically architecture, civil engineering, geography, agriculture, forestry, landscaping, law, sociology, and economy. The courses stress interdisciplinary studies in all phases of planning.

(2) Research and Consultation

The main research activity is the preparation of guidelines for the future development of the entire territory of Switzerland. The purpose of the guidelines is to assist all agencies involved in planning (government as well as private), to coordinate individual planning efforts, and to prevent gross errors and unsound investments based on faulty planning. The Institute has no political authority to enforce the guidelines but they may be used by political bodies for establishing firm planning requirements. It is in this area that ORL is providing substantial consultation services. ORL also assists the Bureau for Housing Construction and thus has a direct influence on the development and location of future housing constructions.

(3) Information System

A specific task of ORL is the establishment and maintenance of a data bank on planning related statistics and facts, based on a small dimensioned grid (unit = 1 hectar = approximately 100,000 sqf). The system is fully programmed and population figures are incorporated in cooperation with the Swiss Federal Statistical Office. The data bank is available to all political subdivisions. Because of the small grid size used, the system is claimed to be helpful in solving even local planning problems.

The new federal law on planning activities is further enhancing the status of ORL, as this 250 member institute will have the responsibility to develop the cantonal development plans required by the new legislation.

f. Institut fuer Baustatik und Massivbau;  
Baustatik und Stahlbau  
(Institute for Structure and Masonry and Concrete  
Construction and Structure and Steel Construction)

The two currently separate institutes will be combined in 1975 at the time of the move to the new campus on the Hoenggerberg. The future emphasis of the new organization will be:

- (1) Application of computers to problems of structures, studies of the actual behavior of building materials and the in-service conditions as basis for the design of structures.
- (2) Investigations on new building materials and construction methods, behavior of elements and complete structures.
- (3) Problems of prefabrication and mass production of construction elements, and cooperation with the Institute for Construction Management.

g. Institut fuer Aerodynamik  
(Institute for Aerodynamics)

The Institute for Aerodynamics was established in 1931 to be active in both theoretic and applied aerodynamics. Although project areas originally were primarily in the fields of aeronautics (the Institute claims to have had the first closed-circuit supersonic wind tunnel), currently the activity includes investigations on the wind resistance of buildings and structures and on thermo-acoustic phenomena in diffusors and pipe lines.

h. Institut fuer Geophysik und  
Schweizerischer Erdbebendienst  
(Institute for Geophysics and Swiss Seismological Service)

The Institute is of interest because of the work in earthquake research. The Service establishes and maintains a network of seismologic stations and studies the seismic activity in the Alpine Region, on the Iberic Peninsula, and in North Africa. Investigations also include safety measures in fault areas and the improvement of measuring techniques and instrumentation.

i. Additional ETH-Z Institutes and Laboratories

All the above institutes have a direct, although in some cases only limited relation to building research and the activities of CBT. A number of other organizations of ETH-Z are active in areas only marginally related to building research. For completeness these are listed below in alphabetical order.

(1) Institut fuer Bau- und Transportmaschinen (Institute for Construction and Transport Equipment). Although currently active exclusively in the area of safety for aerial cable cars, the Institute for Construction and Transport Equipment is scheduled to become more and more active in the field of mechanized construction equipment.

(2) Laboratorium fuer EMPA Lehrbetrieb (Laboratory for EMPA Educational Activity). This is an annex laboratory to the EMPA. Its purpose is to provide facilities for experimental testing in connection with course work on materials testing.

(3) Institut fuer Geodaesie und Photogrammetrie und fuer Kartographie (Institutes for Geodetic and Photogrammetry, and for Cartography). These two institutes are mentioned here because of their relationship to planning in the development of new methods for surveying and mapping.

(4) Geographisches Institut (Geographic Institute). The Geographic Institute is of interest because of its work in ecology and environmental matters. It also cooperates with the ORL by providing essential data for planning purposes.

(5) Geologisches Institut (Geologic Institute). The Institute is active in research concerned with substrata, water tables, and other areas related to planning and building location.

(6) Institut fuer Grundbau und Bodenmechanik (Institute for Foundations and Soil Mechanics). The Institute is concerned with research in foundations and soil mechanics.

(7) Institut fuer Strassen-und Untertagbau (Institute for Highway and Underground Construction). The Institute is active in highway research related to planning. Other activities, such as studies on tunnel construction are of interest in the planning and development of infrastructures.

(8) Institut fuer Kristallographie und Petrographie (Institute for Crystallography and Petrography). Although the total scope of this Institute is very wide, its work in the classification of stones and rocks used as building materials is noted.

(9) Institut fuer Kulturtechnik (Institute for Civil Engineering). The Institute is active in research on problems of drainage and irrigation. It is also active in rural planning and related fields.

(10) Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie (VAW) (Experiment Station for Hydrology and Glaziology). The Experiment Station is concerned with the development of water as a natural resource. The experimental facilities permit the study of water flow and migration both above and below ground level.

### 3.3. Ecole Polytechnique Federale de Lausanne (EPF-L) (Swiss Federal Institute of Technology-Lausanne)

EPF-L was originally established in 1853 as a private technical school, was incorporated in 1869 into the Academy of Lausanne (later University) and was known between 1946 and 1969 as "Ecole Polytechnique de L'Universite de Lausanne", comprising a Department of Architecture and one of Engineering. Since 1969 EPF-L is the second educational institution directly under the jurisdiction of the Federal Government. Its purpose is not only to provide engineering education, but also to be active in research. The management of EPF-L reports directly to the "Schweizerischer Hochschulrat".

Similar to ETH-Z, EPF-L is organized into teaching departments and into research institutes or laboratories. Although teaching staff and Institute management often are combined into one or more persons, the Institutes are not in general a part of the corresponding department, but are independently reporting to the President. It appears that the direction of the various Institutes often is under the supervision of an appropriate commission. The membership of such commissions consists of experts within the school as well as experts from the professions and related industries.

In nine departments, a total of approximately 1700 students are enrolled, and in 1971, 160 students were graduated and 17 doctoral degrees were conferred. Almost one-half of the students are of a nationality other than Swiss.

In 1971, the teaching staff consisted of 73 professors, 217 assistants, some 360 support personnel, and 75 "special staff, the latter being personnel active mainly in the research areas and supported by funds other than the general school budget.

The school is presently located within the city limits of Lausanne, but an entirely new campus is currently being designed for a location of Ecublens somewhat outside of this city. Start of site work is scheduled for Spring, 1973. Occupancy of the first facilities is planned for Fall, 1974, and completion of the first phase with 600,000 square feet floor area is expected in 1978.

Related to the work in building research are six of the EPF-L Institutes:

- (a) "Institut de Recherche sur L'Environnement Construit" (IREC)  
(Research Institute for the Constructed Environment)
- (b) "Laboratoire de Geotechnique" (LEGP)  
(Geotechnical Laboratory)
- (c) "Laboratoire d'Hydraulique" (LHYDREP)  
(Hydrological Laboratory)
- (d) "Institut de Statique des Constructions"  
(Institute for Structures)
- (e) "Institut de la Construction Metallique" (ICOM)  
(Institute for Metal Construction)
- (f) "Institut de Techniques des Transports" (ITEP)  
(Institute for Transportation Technology)

a. Institut de Recherche sur L'Environnement  
Construit (IREC)

IREC was formed only recently. It is planned to provide a multi-discipline approach to a wide range of problems, foremost in the housing field and related to "software" aspects. At present IREC consists of one full-time architect, one full-time economist, one part-time sociologist



and one part-time architect. Additional personnel is employed for short periods as needed, and a small library and information facility is staffed by a part-time information specialist. A substantial expansion of the staff seems to be planned.

The current projects deal with financial, legal, and organizational aspects of housing construction; but an expansion into the areas of performance concept, space perception, and environmental psychology is planned. A comprehensive project into various problems of high-rise building construction has been started recently.

b. Laboratoire de Geotechnique (LEGP)

LEGP is active in the field of foundation and soil mechanic research. Its objectives are to perfect test methods, both in the field and in the laboratory so as to better classify and evaluate soils, and to improve analytical methods for designing foundations.

Currently the research program includes theoretical studies in soil mechanics, properties of rocks, and frost effects; applied research in the area of road and bridge constructions; and both test methods and actual testing and consultation on bearing soils.

c. Laboratoire d'Hydraulique (LHYDREP)

This laboratory is active in the areas of flood control, frequency predictions, and computer studies to estimate fluvial deposits in rivers (originally developed for the Mekong Delta).

d. Institut de Statique des Constructions

The field of research of this institute are studies of the structural behavior on small scale models, for structures which are too complex to be solved analytically, and too large to permit full scale testing. In particular, dynamic effects on structures are studied, such as the behavior of railroad bridges under moving loads. A current project deals with wind forces on buildings and other tall structures.

e. Institut de la Construction Metallique (ICOM)

The research areas of ICOM are: the behavior of composite structures, the elastic-plastic stability of frames, new applications of the finite element method, and studies on effective safety factors of structures.

Specific current research projects deal with the behavior of composite steel and concrete framework, both under static and dynamic loads; post-buckling behavior of light gauge sections, both open and closed; analytical

determination of post-buckling behavior of metal beams; behavior and design of sandwich panels; application of finite element method to welded constructions. Future planned work includes studies on the use and application of light-weight concrete.

f. Institut de Technique des Transports (ITEP)

Studies of ITEP include all aspects of transportation, but with emphasis on rail-type systems. In general, ITEP is concerned with the software aspects, such as mathematical models for pre-determining distribution, density, and "bottlenecks", and on management systems for transportation. In the planning field, several studies are being carried out under contract for rural and urban jurisdiction both in Switzerland and in Algeria.

ITEP is cooperating with the Department of Engineering and its Institute on Electric Machines, in the development of a new transportation system based on the application of the EPF-L developed "Moteur Lineaires Asynchrones". In this motor, the stationary rail becomes an integral part of the motor which does not have any rotating parts. By not relying on wheels for transmitting the motive power to the rail the system (if sufficient power is used) has no limits in regard to slopes - it can even be used for vertical transportation; it also does not rely on mechanical friction for breaking. A 94 m (275 ft.) long test rail is installed at the EPF-L site permitting the testing of motors from 15 to 30 KW. In connection with this development project, the staff is in contact with the U. S. Department of Transportation (DOT). Prof. Genton of the Institute has contacts with:

Mr. de Concini, International Relations; and

Mr. Robert Dial, Chief, New Systems Requirements Analysis Branch,  
Urban Transit Administration.

Prof. Jufer of the Institute is in contact with:

Mr. Matthew Guarino, Jr., Project Engineer, Electrical Propulsion  
and Power Systems, Office of High-Speed  
Ground Transportation.

g. Additional EPF-L Research Institutes

In the "Department du Genie Rurale", some additional work is potentially applicable to housing and building research through the following four organizations:

"Institut de Photogrammetrie"  
(Institute for Photogrammetry)

"Institut du Genie Rurale"  
(Institute for Rural Civil Engineering)

"Institut Genie de L'Environnement"  
(Institute for Environmental Sciences)

"Institut de Petrographie"  
(Institute for Petrography)

These institutes are mainly concerned with engineering sciences applicable to rural areas, and to regional planning efforts. The first two institutes deal with methods of triangulation and the development of small scale maps and plans. The third is not yet operational, but will deal with air and water pollution, energy conservation, and waste disposal and recycling. The last one interfaces with both building materials and building subsoil.

3.4. Eidgenoessische Materialspruefungs-und  
Versuchsanstalt fuer Industrie, Bauwesen und Gewerbe (EMPA)  
(Swiss Federal Materials Testing and Experiment Station)

Also known by its earlier name of "Eidgenoessische Materialpruefungs-Anstalt", EMPA is the leading Swiss organization in the testing field.

The institution was founded in 1880 as an organization for testing building materials in connection with the Swiss Polytechnique Institute (now ETH-Z). Between 1895 and 1937 the scope of EMPA's work was expanded so that today all areas of industry and commerce are represented in its testing program. Today building and general construction related testing account for approximately one-third of its total activity. In addition, EMPA has also undertaken labelling and certification programs in some areas.

The main facility of EMPA is located in relatively new buildings in Duebendorf near Zurich. A smaller facility, a former textile laboratory, is located in St. Gall. However, only activities in textiles, leather, paper and related testing are conducted in this annex.

Prof. T. Erisman is director of the entire organization. He reports to the "Schweizerische Hochschulrat". The "Advisory Commission of the EMPA" is assisting the Schulrat and the EMPA, and a special commission advises on activities related to the St. Gall operation.

As of December 31, 1971, the organization, including the St. Gall facility, consisted of a total of 479 employees, of which approximately one-half are classified as professionals (with a college level degree) and approximately 60 are apprentices and temporary help. Sixteen members of the staff are actively engaged in teaching, mainly at ETH-Z.

The total budget for 1971 was approximately SFR 17,600,000 (or \$5,500,000), of which SFR 12,100,000 (\$4,000,000) were employment costs.

The organization chart shown in Figure 2 identifies the departments and indicates the names of the respective chiefs.

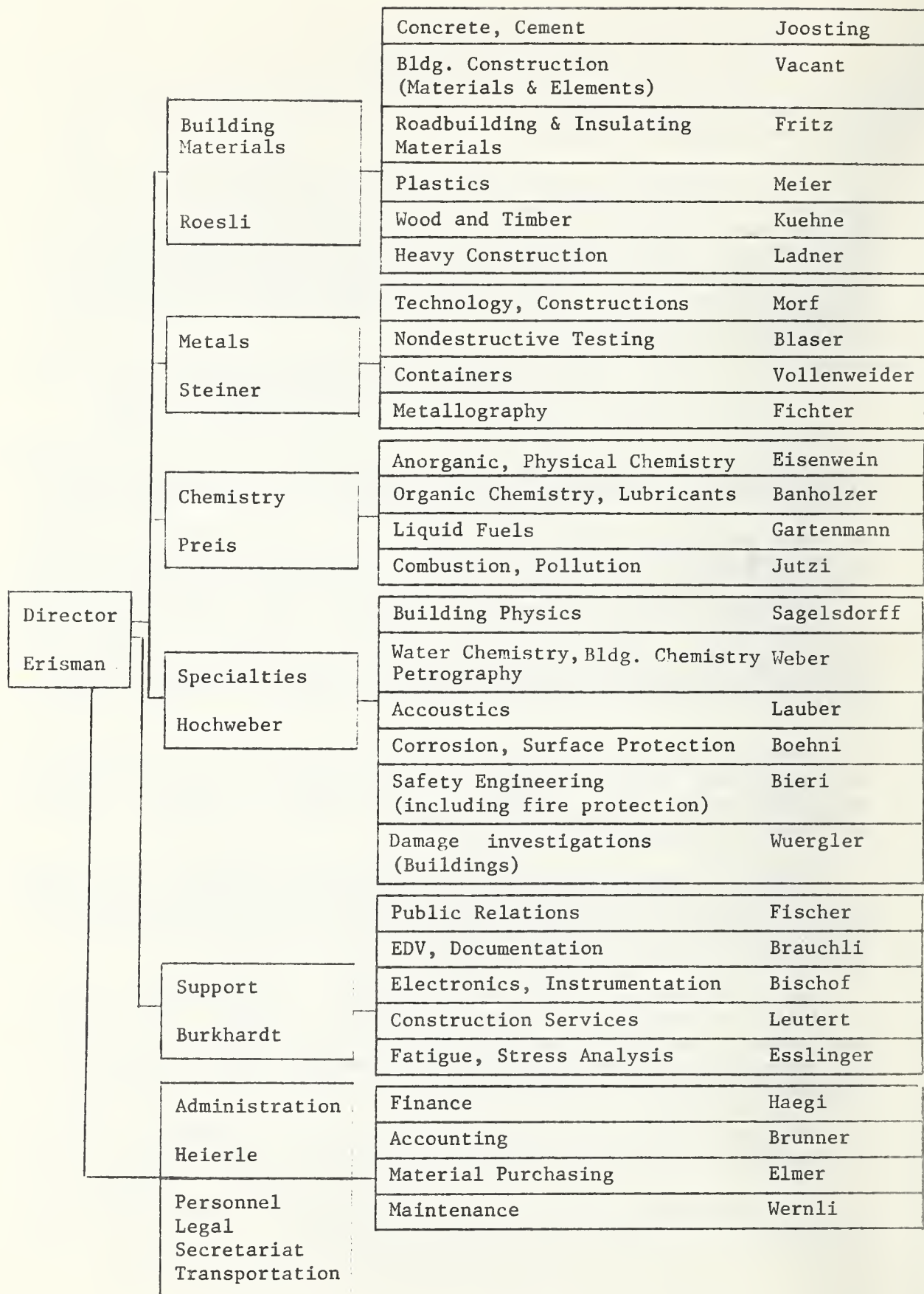


FIGURE 2. ORGANIZATION OF EMPA DUEBENDORF

Despite its position as a federal agency and its teaching functions, 80 percent of EMPA's income and expenditures are related to commercial testing and other sponsored activities for private industry. Research activities are generally restricted to:

- (1) Research that is needed to maintain the professional level of the organization.
- (2) The research that relates directly to practical aspects of testing, particularly to apparatus, instrumentation, and methods of testing.
- (3) Research activities conducted in close cooperation with outside organizations.

Although the restriction to the three areas listed would appear to leave little room for meaningful research, many of the sponsored activities are in fact applied research, as only part of these are in the area of routine testing.

Close cooperation with the ETH-Z is maintained through teaching activity at ETH by many of EMPA's staff members. In addition, EMPA conducts its own classes in material sciences, some of which are built into the required curriculum for engineers at the ETH-Z.

In regard to building research, the following departments are of particular interest:

a. Department of Building Materials

The department is concerned with mechanical and structural testing and evaluation of non-metallic materials and products, components, and constructions, including reinforced and prestressed concrete and composite constructions. The emphasis is on applications in general and building construction.

In the area of concrete and concrete products, the evaluation of concrete, cement, aggregates, and additives are of major concern to the department.

b. Department of Metals

The Department is concerned with testing of metals (particularly steel) used in building, machine, and container applications.

In the building construction area load tests both on components (in laboratory) and on completed structures (in field), and welding inspections during construction are of major interest. Through this activity

in welding inspection, the Department is tied into the building regulatory system by conducting mandatory field inspections and tests of weldments.

#### c. Department Special Problems

This Department is concerned with testing in the fields of building physics and building chemistry, such as thermal and humidity aspects of building and component performance, fire protection technology, corrosion, and building accoustics. The development of window test methods for water and air infiltration and for accoustic performance; investigations in the area of building safety in regard to fire and explosion; and building failures and damage investigations are some examples of the work of this department.

#### d. Department Supporting Services

Ancilliary to the above departments are sections which deal with information and data systems, measurement and electronic technology, and fatigue and stress analysis.

#### 3.5. Schweizerisches Institut fuer Aussenwirtschafts, Struktur, und Marktforschung (Swiss Institute for Foreign Commerce and Marketing)

This Institute is attached to the University of Economics and Social Sciences of St. Gall. The Institute is organized into the Departments of International Economic Affairs and Planning and Market Research. It is the latter of these Departments that is active in the housing field. The two project areas currently under study are housing statistics and methods for increasing housing construction.

The work in statistics includes close cooperation with "Baudata-Systematik" (Page 33) in developing uniform accounting procedures, the development of a nationwide building cost index, housing distribution, and housing cost (both rental and construction).

In the area of method for increasing housing construction, the studies include the definition of the various economic factors which determine the supply of housing, and the influence of various governmental efforts, such as construction subsidy programs, publicly owned housing, and rent subsidies.

As likely future projects were mentioned economic studies on: urban renewal, import duties, foreign contractor competition, administrative protectionistic acts and other restrictions such as building codes.

The Institute employs a total of approximately 20 persons including teaching and clerical staff. Active exclusively in the area of building research are two graduate (pre-doctoral students and two part-time students, reporting to Professor Nydegger, Director of the Institute.

3.6. Schweizerischer Ingenieur und  
Architekten Verein (SIA)  
(Swiss Association of Engineers and Architects)

SIA is the major professional association of Swiss engineers and architects.

The objective of the Society, as stated in its bylaws is the protection of the interests of the professions of engineering and architecture, and the development of standards. In pursuit of these objectives, SIA develops standards in the areas of:

Definition of professional activity

Fees schedules

Professional ethics

Definition of types of construction activities

Bidding procedures

Contract arrangements (including publication of contract forms)

Cost and accounting procedures

Engineering and design procedures

Strength and performance of materials, products, and components.

Standards developed in the last two areas are referenced in most building laws and regulations and are the equivalent of part of building codes and ASTM standards used in the United States. These standards do not, however, constitute a comprehensive collection of reference standards, but are developed on a selective basis. Instead of being referenced directly in laws and regulations, they are often implied by such statements as "according to good engineering practice".

The Society develops the various standards through committees and subcommittees. Only Society members - and accordingly only professionals - can serve on these committees as full members. Consumers (other than indirectly through architects and engineers) are not represented, and neither are producer interests. Informally, however, producers do liberally cooperate with the various committees, and many SIA materials standards appear to be simply industry standards adopted and approved by the Society. The lack of formal and effective representation by consumer and producer groups does not seem to be considered important. In fact, the lack is not even perceived as such.

3.7. Schweizerische Zentralstelle fuer  
Baurationalisierung (CRB)  
(Swiss Center for Efficiency in Building Construction)

CRB is a non-profit organization, financed by 30 percent through membership fees, 20 percent through Federal Government subsidies, and 50 percent from the sale of literature. With an annual budget of approximately SFR 1,000,000 (\$300,000), the organization has a full-time staff of five and a part-time staff for a varying total of between 12 and 25.

The objective of the organization is the promotion of efficiency in the building construction and contracting area through the development and publication of "software" methods and procedures. It is active foremostly in the area of cost accounting, but has substantial interests in the entire construction process, including:

Construction Management theory and methods

Modular coordination.

Documentation of available building systems, literature and publications on all aspects related to its area of activity.

Research in mathematical models for building and building construction processes.

CRB appears to enjoy the active support of most persons interviewed. In particular its efforts are recognized in the industry sector. The major contribution of CRB seems to be in the area of reduced contractor and architect's overheads.

3.8. Institut fuer Bauberatung  
(Institute for Construction Consultation)

This is a private organization and a division of "Fides Treuhand AG" (corporation) owned by Swiss Credit. The organization employs approximately 12 architects, engineers, and computer programmers.

The objective of the organization is to provide, on a commercial basis, consulting services to building owners and architects in the area of cost control, time planning, and construction management. To perform these services, the Institute has developed various PERT and CPM systems for data manipulation.

All the systems currently used are based on single individual contracts and do not extend to contractor's internal cost accounting. However, the systems could be used by general contractors or in "construction management" situations.



Although the systems are not developed for this purpose, it would be possible to use them for optimization based on cost and time factors. At this time the difficulty would exist in the lack of reliable input data.

### 3.9. Baudata Systematik (BDS) (Building Construction Information System)

This is an informal non-profit organization with the objective to develop a uniform and systematic data and documentation basis for the entire building industry.

The organization also attempts (and appears to be quite successful) to promote the use of a uniform data system by producers in their sales literature.

BDS has no staff other than the Secretary (Mr. Held) and operates under the consensus principle. The membership is almost exclusively composed of professionals with little input from either the consumer or producer categories.

### 3.10. Battelle Memorial Institute - Geneva

The Battelle Memorial Institute maintains a major establishment in Geneva. As all other individual Battelle Institutes this one operates essentially independent from the main office in Columbus, Ohio, U. S. A.

One division with approximately 12 employees is exclusively active in the building research area. All projects are of the "software" type, there being no facilities for experimental work available. Major project areas are:

#### a. Pre-evaluation of Building Research Projects

This project is sponsored by FKW for its use in evaluating research proposals and for determining priorities of suggested projects.

#### b. Structure of Swiss Building Research Activity

This study is currently in the editorial stage and a copy of the final report was promised to be sent to this investigator.

#### c. Thermal Insulating Materials

A study of present and future needs and availability of insulating materials in regard to economic and technological considerations.

#### d. Environmental Factors in Industrial Buildings

The study is to consider space, noise, vibration, humidity, air, and light in industrial environments, and the influence of these factors on

occupant satisfaction, health, and productivity. An integrated approach is planned for this project which is sponsored by an Italian automobile manufacturer.

e. Study of Housing Construction, Housing Needs,  
and Industrialized Housing Construction

This is a cooperative project with other Battelle Institutes and covers selected countries on a worldwide basis. This privately sponsored project attempts to determine (1) where industrialized housing construction in fact is proven successful, and (2) what factors are needed for successful industrialized construction.

f. Future Projects

Sponsored by the Canton of Geneva, Battelle will study housing and building economics, and the entire complex of questions of transportation for the Canton of Geneva. This Canton is almost entirely surrounded by French Territory and is furthermore divided by the lake and the Rhone River. Urban mass transportation is considered the major key in all future development plans.

3.11. U. Hettich, Architect

Mr. Hettich is a partner in a cooperatively organized architectural firm. He is also the former chief of the technical office of FKW. He was recently appointed Chief of the Bernese Cantonal Building Department. He will assume this post in the Spring of 1973.

In his capacity as Chief of the Technical Office of FKW, Mr. Hettich was instrumental in developing the original research program of this organization. Since his resignation he has maintained his interests in building research and is now both a member of FKW and one of its contractors. In the latter capacity he is active on two projects:

a. Measurement of "Housing Quality  
(Performance of Housing)

Under the pressures of high demand and rising land prices, it is believed that the housing costs to the consumer are not depending greatly on actual construction cost, as cost savings to the contractors are not passed on to the consumer. Accordingly, Mr. Hettich is of the opinion that building research should aim more at the improvement of the housing quality (at equal cost level). However, any effort in this direction presupposes a method for measuring this quality. The project goal is the development of such a method.

### b. Rehabilitation of Housing

Consistent with Mr. Hettich's findings in regard to the improvement of housing performance, he proposes in this project the study of the rehabilitation of existing but substandard housing. No results were available from this study at this time.

#### 3.12. Mr. H. Litz, Architect

Mr. Litz is an independently working architect with several large housing development designs to his credit, as well as substantial experience in the development of concrete housing systems. However, his present main interest is in the area of modular coordination.

Mr. Litz has been Ernst Goehner AG's leading consultant for many years, both in the design of building systems and entire developments. When he originally developed the "Goehner System", it was planned to produce an open system of components which could be used for the construction of various differing housing units. He still believes that this would have been the correct, and in the long run the more successful course (the Goehner System as currently being built is a closed system of components each designed for the specific building type).

Through his work on concrete components, Mr. Litz became interested in modular coordination. He is the author of several publications and research reports on this subject which is his major current interest.

#### 3.13. Suter & Suter, Architects

Suter & Suter is the largest strictly architectural firm in Switzerland. The firm is not involved in contracting, financing, or development work. It employs a total of 450 architects, designers, draftsmen, job superintendents and clerical staff, of which approximately 50 are stationed in subsidiaries in other cities of Switzerland, in France, Germany, and Austria. Suter & Suter builds worldwide with a total annual building volume of approximately SFR 500,000,000 (\$150,000,000). The firm originally specialized in buildings for the industry (particularly chemical and pharmaceutical) but is active today in all building types, although industrial construction still seems to predominate.

Suter & Suter often uses prefabricated elements in its construction in combination with conventional methods but not complete prefabricated systems.

Suter & Suter has pioneered in the area of construction cost accounting and much of the current developments by CRB and the "Institut fuer Bauberatung" are based on this early work. At present Suter & Suter uses a computer based accounting system to monitor the cost performance of all its construction work.

Suter & Suter has established a special working group (ICARE) which concerns itself with research related activities. Its four main tasks are:

Development of standardized details, mainly in industrial construction. These details are for internal use only and are continuously updated based on experience in the field.

Cost estimating and statistics. Based on internally and externally available information, detailed cost statistics are developed and maintained. These statistics are used to monitor the cost of proposed designs at all stages of development.

Every department has one man assigned the task of reporting to ICARE any deficiencies or difficulties discovered. This information is collected, reviewed, and disseminated among those internal departments which might need the information. ICARE also develops statistics from this information and uses it for updating standard details and cost estimate information. In fact, this activity is an organized internal "feedback".

In addition ICARE prepares testimonies and cost estimates on existing constructions, both for internal use and on a commission basis for third parties.

Suter & Suter has in the past used outside consultants for confidential surveys of occupant satisfaction in housing construction. The results of such surveys served not only for design improvements but also in promotional activities. The organization also maintains continued informal contacts with owners and maintenance personnel, and credits this fact for the large number of repeat commissions.

#### 3.14. Edward Helfer, Architect

The office of Mr. Helfer is active both as designer of buildings and housing projects and as developer.

Because of this dual involvement in multi-family housing he has become active in three research related activities:

##### a. Industrialized Construction

In effect, E. Helfer's organization has developed their own precast concrete building system. It is an "open" system and is easily altered to adapt to each project requirement. It also appears to be used frequently in combination with conventional construction. Cost savings realized through the use of his system over conventional construction are reported to be in the 10 percent range.

### b. In-Office Standards

Helfer's office is developing standard details and standardized dimensions for their own use in conventional construction. The development of these standards are pursued independent of current projects.

### c. Feedback

For his own use, Helfer's office is continuously monitoring and documenting the performance of its construction, including such items as customer satisfaction, operating, and maintenance cost. The data so collected is treated as confidential.

In all, Mr. Helfer's organization earmarks 10 percent of its profits for research and development activities.

The organization consists of approximately 75 persons including architects, designers, draftsmen, job supervisors and clerical staff. The building volume is in the range of SFR 70,000,000 (\$20,000,000) per year, of which the organization is co-owner in roughly half of the projects.

### 3.15. Ernst Goehner AG

Ernst Goehner AG is the largest Swiss housing developer, currently owned by Electro Watt AG. Grown originally from a millwork shop and window factory (Goehner was one of the first to offer standardized window sizes), it is best known today for its prefabricated concrete building systems for housing construction. However, over one-half of its housing construction is built conventionally. Goehner also builds non-residential structures and these are all conventionally built. In 1971, the total building volume of Ernst Goehner AG was SFR 217,000,000 (\$70,000,000).

As a developer Goehner builds large housing developments in the 1000 to 3000 unit range, the majority in medium and highrise structures. Most developments are on the outskirts of Zurich on undeveloped rural land. Although Goehner does own a few of its developments, the majority are built on the turn-key principle for sale to large investors (such as insurance companies). At the request of the client, Goehner not only designs and constructs the buildings, but also provides initial building management services, such as initial renting and training of maintenance personnel.

The design of most developments is under the direction of Mr. Litz, Architect, who was also instrumental in the development of the building system.

The "Goehner System" is a typical precast concrete system consisting of various floor, wall, and partition elements. It is essentially a "closed" system.

Goehner (with Mr. Litz as project architect) has been successful in bringing variety into their developments by varying building heights, the liberal application of color, the integration of different building types such as kindergartens with their different scale, and through imaginative site design and landscaping.

Goehner has commissioned a number of studies in the general area of "feedback", mainly for use as a marketing tool and as a basis for changes in subsequent projects. Much of this information is also of general interest.

### 3.16. Karl Steiner General Contractors

Only in recent years have general contractors appeared on the construction scene in Switzerland and their activity accounts for only a small fraction of the total construction activity.

Karl Steiner uses methods of "pre-design" and "pre-engineering" of details and components, but believes that the so-called systems are not truly competitive. Questioned as to why then systems building appears to be well developed, and accepted, in Switzerland, Steiner personnel indicated that in today's market "anything can be sold".

The representatives of Steiner indicated that their own organization does not conduct any research, but expressed a strong recognition of the need for such activities. They expressed the opinion that such research would best be conducted by a private organization whereby research objectives should be determined by consensus of the various segments of the building industry. They also indicated that the present lack of research activity by private organizations is due to the high economic cycle in which little incentive exists for increasing the efficiency. The demand for "just getting things done" is too great to leave time for activities which are not related directly to today's problems.

Their own greatest problem was stated to be the lack of information flow within their own organization, particularly the lack of feedback from the site to the engineering department. As Steiner is active in various areas of Switzerland, the multitude of building laws and codes is a major problem area.

### 3.17. Planning Bureau of the City of Berne

The objective of the Bureau is the guidance of the orderly expansion of the building inventory in the City of Berne. The Bureau works very closely with the Cantonal Planning Department. In fact, the two organizations are located in the same building and some of their functions seemed to overlap.

Based on Cantonal laws and City rules and regulations, the City Planning Bureau develops and maintains a "guide plan" for the entire territory and establishes specific regulations and zones for selected development areas. In this work, the Bureau considers present and planned transportation networks and facilities, population projections, performance of established building projects, sociological factors, movement of occupants. Specifically, the Bureau does conduct comparative studies in owner satisfaction and project comparisons. These efforts are similar to "Feedback", except that they are conducted informally and on a modest scale. The Bureau would like to be able to do these studies more methodically and in larger scale, but lack of both funds and personnel prevent additional work in this area. The Bureau also recognizes that sociological aspects are not sufficiently developed and considered in its planning efforts. Within budgetary limits it is planned to develop a small organization devoted exclusively to data collection and evaluation so as to strengthen the Bureau's capabilities.

Within the "guide plan" (or master plan), private developers are encouraged to develop specific projects. These developers may be individuals or are more commonly groups of persons with financial or professional interests, such as banks, insurance companies, architects, and contractors. The projects vary from single buildings to integrated neighborhoods with up to 3000 apartments with all auxiliary services and required infrastructure, such as kindergartens, schools, shopping centers, health and recreational facilities. The Bureau appears to very actively participate in both the planning and execution of these projects, although this participation seems to be informal.

As one of the specific tasks of the Bureau and of the "guide plan", the maintenance of free (undeveloped) spaces and areas was identified. These spaces may be public parks, but are more often agriculturally used areas. In the cases where continued agricultural production on such land is no longer profitable, support by subventions are considered a compensation for profit that could be realized if the land were zoned for development.

In a short visit to several projects (Gaebelbach, Tscharnergut) it was found that modern planning ideas were realized to a high degree. The aesthetic overall approach also was very successful.

### 3.18. Delegation du Logement du Canton de Geneve (Housing Commission of the Canton (State) of Geneva)

The "Delegation" is a recently established organization which is responsible for the overall planning of housing in the Canton (State) of Geneva. It is part of the Cantonal Government and acts in a coordinating function. The delegation is committed to an integrated approach based

largely on the results of sociological research. It also has available funds for sponsored research in specific problem areas (e.g. transportation, see under Battelle).

Current housing construction in the Canton is characterized by the fact that 80 percent is subsidized in one form or other, and that Geneva was one of the first cantons in Switzerland to adopt a comprehensive zoning plan. This plan provides for five zones, one of which is established as "development zone". Unlike the other four conventional and relatively rigid zones, this one permits considerable freedom in land-use and density. However, in this zone the developers are required to assume a larger share of the cost of infrastructure. By this means it is hoped to achieve three goals: (1) to provide the necessary funds without increasing the tax burden of the other areas; (2) to reduce the potentially enormous speculative profits by present land owners; and (3) to eliminate or reduce the monotony of conventional zones. This latter aspect is admittedly speculative at this moment and constitutes an interesting large-scale experiment in city and regional planning.



#### 4. BUILDING RESEARCH PROJECTS

In this section, a limited number of selected typical and significant research projects and project areas are briefly described. However, prior to the discussion, a few general observations may be of interest:

(a) Few projects are truly interdisciplinary in nature; the personnel directly involved in the single projects being either all of the same or closely related disciplinary background, or having only a token participation by substantially different disciplines. Only in the area of planning has full interdisciplinarity been achieved.

(b) The total research effort appears very well coordinated and directed. For example, in the area which could be called "preconditions for industrialization" a logical development is clearly discernible: standardization of cost accounting positions leads to uniformity in quantity surveys (development of "Baukostenplan" or "building cost plan") and to the development of a uniform "catalog" of building parts. The definition of the single building parts and their interfaces constitute a first precondition for the industrialization of their production. Studies on the modular coordination of the defined building parts and their limitation to a relatively few sizes provides the second precondition. Based on additional studies into specific design aspects and legal restrictions (codes), performance characteristics (or specifications) can then be developed to provide the third and final precondition for the industrial production of single building parts, elements, or even complete modules. For each of these steps one or several research projects have been defined by FKW and are either completed, under study, or proposed as "future work".

(c) Another noteworthy aspect of Swiss building research activity is the liberal and conscious use of preliminary studies. These tend to go far beyond typical state-of-art studies and include both project justification and project description. Thus they not only lead to more efficient research studies, but appear also to prevent unneeded projects from being established.

(d) Finally, with regard to project content, the Swiss definition of housing research (and probably also of building research) appears to apply primarily to the "software" aspects of the problem area, as with the exception of the activities at the EMPA and at some of the institutes attached to the engineering departments of the two Federal Institutes of Technology, no "hardware" oriented projects were found to exist. Also, all but the above-mentioned organizations lacked facilities for experimental work. It appears that "hardware" is considered essentially product oriented, and product design is not considered part of housing or building research, but rather to belong into the responsibility of private producers.

#### 4.1. Building Economics

A substantial research effort is under way to reduce the indirect cost of building construction, particularly in the area of contract preparation, contract administration, and accounting. These projects are widely supported by the building industry as their results directly benefit not only the consumer, but also architects and contractors, particularly in the present seller's market. Several persons interviewed indicated that these efforts in themselves do not substantially affect total construction cost, but that these projects are directly related to and necessary preconditions for the future industrialization of the construction process.

Additional research in building cost statistics and in subsidy programs also fall under the heading of building economics and land cost.

##### a. Baukostenplan

Originated by the architectural firm of Suter and Suter, the "Building Cost Plan" was developed in its present form by the "Schweizerische Zentralstelle fuer Baurationalisierung" (CRB). It is an organized plan, or format, for listing building construction cost for purposes of estimating, bidding, and cost control. Although the plan permits as detailed a breakdown of cost as needed for a specific purpose, three significant digits are used and are predetermined. The first group, signified by the first digit, divides the work types into ten broad groupings, such as 0 for land cost, 1 for preliminary work, 2 for building, . . . to 9 for interior movable equipment and furnishings. The second digit describes a more detailed breakdown, for example 21 denotes the basic structure (supports, floors, and walls). The third digit signifies the final predetermined detail cost position, for example 211 would thus correspond to masonry. Additional subdivisions are possible, and guidelines for their use have been developed.

The "Baukostenplan" is based on activity types or trades, e.g. "masonry", "carpentry", "hardware", and is thus not easily used in those cases where prefabricated elements combine several activity types, such as, for example, prehung doors which include both carpentry and hardware positions. Accordingly, work is currently in progress to expand the plan to accommodate such components.

The advantages claimed for the plan are the possibility of using cost breakdowns as detailed as required, or as available. Thus, for early estimates to determine the magnitude of cost, only the first broad groupings (or first digit) are used; for preliminary estimates, two digits may be useful, and for contract documents, three digits (and any further necessary subdivision) are used. The system, if consequently used, permits cost comparisons even of widely differing building types, and provides the necessary data for future cost estimates. It appears that the "Baukostenplan" is used widely in Swiss building construction.

## b. Bauteilkatalog

The "catalogue of building parts" is a document intended as a companion document to the "Building Cost Plan" so as to permit meaningful cost accounting for prefabricated elements and equipment. In addition the "catalogue" interfaces with the development of modular coordination and with the entire complex of questions related to performance specifications. The development of the "Bauteilkatalog" is currently in the preliminary stage.

## c. Cost Comparison of Housing Projects

Two projects in this area are currently under study at the "Institut fuer Hochbauforschung" (HBF):

a. A comparison and study is being made of various cost evaluation methods and systems. Dutch, French, and British methods are studied for their applicability to Swiss conditions.

b. Four housing projects of the City of Zurich are being compared. The four projects differ in the degree of prefabrication used, from totally conventional on-site construction to a method using large concrete elements. Based on total construction cost, the housing unit cost of the conventionally constructed project was the lowest with a cost of approximately 8% less than the most expensive system. However, the projects were not identical in size, room layouts, and other aspects and these differences may be responsible for cost variation higher than those observed between the different construction methods. A more detailed "adjusted" cost analysis is currently in progress.

c. In a companion project at HBF, the economic effect of the number of parts in production series is being studied. This investigation is needed because building components are produced in relatively small series and with many variations, both conditions which in prior studies of industrial production were not considered.

In addition to these formal studies, individual architectural firms (Suter & Suter, Ed. Helfer), contractors, and builders also are continually monitoring and comparing the economics of various construction methods and building systems. It is interesting to note that the opinions regarding the relative cost of conventional and industrialized construction varied widely.

## d. Statistics in Building Construction and Cost

The "Schweizerisches Institut fuer Aussenwirtschafts, Struktur, und Marktforschung" in St. Gall, is developing methodologies for the treatment of statistics in various building related applications.

Although various localities have for some time developed building cost indices, these are not based on a uniform method and are therefore

not comparable. The Institute is currently developing a methodology to establish a nationwide building cost index, and is collecting the necessary data to form the basis for the numerical value of the index.

The other group of statistics, both in regard to methodology and numerical treatment, is in the area of housing production, housing distribution, use change, and demolition. The statistics so developed will be used as data for some of the other work of the Institute.

#### e. Methods for Increasing Housing Production

The Institut fuer Aussenwirtschafts, Struktur, und Marktforschung conducts studies to determine the influence of various economic factors on the supply of housing. The emphasis of this work is to investigate the effects of various methods of public assistance, such as direct subsidies, rent subsidies, public housing, and others. The results of these studies are expected to have a direct influence on future legislative proposals in this area.

An extension of this work is planned to include factors of urban planning and urban renewal, competition from foreign contractors, industrialization of housing construction, tariffs and administrative restrictions on imported building materials and components, and of building regulatory restrictions.

#### f. Financial Aspects of Landownership

The "Institut de L'Environnement Construite" (IREC) at EPF-L plans an extensive study into all aspects of land cost, their determination, and their effect on both housing production and housing cost.

The project is to investigate the financial aspects of landownership and their relation to housing production and housing cost. It will investigate the definitions of evaluation criteria, and their use in the decision making process in housing construction. In effect, it studies the question of what is the value of a particular piece of real estate property, what are the components of this value, and how are they determined. The results of the project are hoped to become a management and decision making tool for use by private builders and developers, as well as by various public and government agencies involved in housing construction.

#### g. Analysis of the Housing Production Process

Also at IREC a project investigates the relative importance of the various parties in the housing production process, such as public agencies, public services, landowner, developer, financial institutions, architects, contractors, users, etc., and the influence these parties have on the decision making process. By developing an order of priorities it is proposed that the more important influences be further investigated.

#### h. The Role of the Developer

Because the role of the developer is claimed to be the least clearly defined and understood in the total process of housing production, this project at IREC (EPF -L) has the objective to identify the developer's financial and economic function in relation to financial institutions and investors, and his decision making power in the field of environmental quality.

The project is based on the fact that, from the standpoint of rental income (earnings), real estate investments are currently among the least attractive in Switzerland.

#### i. Economics of Heating

Extensive studies in this area have been completed by various ad hoc groups under contract with FKW. The investigations included first studies of comfort conditions as determined by air temperature, surface temperature of space enclosure, temperature distribution, air humidity, air movement, and the condition of the individual (rest or activity). Second, the energy consumption for various heating systems and various building and comfort conditions were investigated. Based on the above factors the heating cost were studied both in regard to operation, first cost, and total cost, including depreciation with assumed useful life for each separate equipment component. The results of these studies are a comprehensive method not only for predetermining total heating cost for a given building, but also for the selection of the optimal combination of insulation, heating plant, and heating fuel. Future work in this area is expected to include the development of more meaningful statistics of cost, equipment performance, and the comfort requirements of individuals.

#### 4.2. Modular Coordination

As mentioned earlier, modular coordination is considered as one of the necessary preconditions for the industrialization of the building process and the building industry. Accordingly, a concerted effort in this area is under way in Switzerland.

The major exponent of these efforts appears to be architect H. Litz, who is heading a special task group composed of representatives from industry and various other interests. The group works under contract with the FKW. The work is closely coordinated with other European efforts on this subject.

A detailed discussion of the technical aspects of Mr. Litz's activity would go beyond the scope of this report. However, although substantial progress appears to have been made so far, it is interesting to note that Mr. Litz foresees his personal efforts in this area to continue for at least another five years.

Mr. Litz inquired about the progress of "metrication" in the U.S.A. and expressed his hope that a system of meaningful modular coordination in building construction be developed concurrently with the reorganization of the measurement system.

#### 4.3. Evaluation of Proposed Housing Projects

Government housing subsidy agencies, planning offices, and private investors all use currently different methods for the preevaluation of housing projects, all based on different criteria. None of the methods used at present consider all aspects (economic, social, spacial, political, etc.) and none except for the economic aspects in a narrow sense are based on objective valuation; instead most decisions on the desirability of any one housing project is largely based on subjective judgment.

Architect Hettich is developing the methodology for the objective preevaluation of housing projects for use mainly by subsidy agencies. The methodology is expected to consider technologic, economic, social, spacial, and environmental factors. Since many of the factors involved can not at present be expressed in numerical values, an initial phase of the project consists of developing "measuring sticks" for selected major factors.

In regard to the final preevaluation method, Mr. Hettich expects that for each performance attribute a lower acceptable performance level will be established, together with a "lowest allowable total", this total being greater than the sum of all lowest acceptable performance levels. Through this method it will be possible for the designer or developer to effect trade-offs which are expected to provide a needed flexibility not available with present "minimum property standards" system and which should lead to both improved economics and a more varied supply of housing.

The "Institut fuer Hochbauforschung" (HBF) at ETH-Z is working on the methodology for developing performance criteria in the area of housing construction. While Mr. Hettich's project is more oriented toward habitability, the HBF project is more related to the physical aspects of building materials, components, and parts.

#### 4.4. Evaluation of Proposed Research Projects

Because FKW is sponsoring a relatively large number of research projects, the need for an objective evaluation method for research proposals became apparent. Accordingly, Battelle Institute - Geneva, has developed a comprehensive evaluation system.

The methodology calls for the consideration of various factors, such as:

Frequency of potential applications -  
Number of housing units affected - number of rooms in  
housing unit affected;

Degree of use of potential applications -  
Hours of use;

Potential construction cost savings;

Potential other benefits;

Likelihood of success.

The system is quite complex, but appears to be well thought out. The major difficulties foreseen are lack of reliable numerical input data, and the fact that the relative weight given to the various factors is largely based on subjective judgment. Battelle recognizes that political and other factors not considered in their study may, in specific cases, be of even greater importance than the factors considered. However, the system under development should be useful as a management tool for organizations required to evaluate and select research proposals.

#### 4.5. Building Design

Substantial work is in progress in developing guidelines and recommendations for the design of housing units and their equipment.

Basic investigations on space requirements for various furniture and equipment placements were made, largely to update earlier recommendations as given in many architectural handbooks. The results of these investigations are also expected to be used in the housing evaluation studies.

An important position is taken by studies and investigations into housing user needs, particularly for housing the aged, the infirm, and a group referred to as "social orphans", under which name are to be listed single adults with dependents and persons with some mental handicap. For example, unwed mothers would fall into this category. Most of these studies are considered as interdisciplinary socio-economic problems.

An investigation into the physiological requirements as a basis for building planning and design was undertaken by an interdisciplinary task group under contract with FKW. The report of this work is a most complete, and well documented paper on all those aspects of housing design which are directly related to physiological human needs.

#### 4.6. Land Use and Planning

Land use and planning are both considered integral parts of the building and housing construction activity. Accordingly, the research in these areas also are integral parts of housing and building research.

The specific activities in land use and planning research are described under 2.3.b. Planning, on Page 9; 3.2.e. Institut fuer Orts-, Regional-, und Landesplanung (ORL), on Page 21; 3.17. Planning Bureau of the City of Berne, on Page 38; and under 3.18. Delegation du Logement du Canton de Geneve, on Page 39.

In general, research in land use and planning appeared to be well developed, although many of the persons interviewed insisted that British, Scandinavian, and U. S. planning research is further developed.

#### 4.7. Feedback

Except for the largely promotion-oriented efforts of large builders and one architectural firm, no organized system for collecting and coordinating performance information from newly built housing was found. However, the subject appeared to be of great interest to many persons and organizations contacted. While most of those interviewed believed that the information flow from designer to fabricator and erector generally is well and successfully organized, the flow of information (experience) in the other direction, that is from occupied building, erection site, fabricating shop, to drawing room and design department is either non-existent or largely left to accident. This flow used to be maintained through personal site inspections and was not as critical as long as only conventional building methods were used for which many years of experience existed. It was pointed out that due to understaffing proper personal inspections are no longer possible with the same frequency on one hand, and that on the other, the increased use of new materials and building methods as well as new planning principles has increased the need for feedback. Although no research projects were found to exist, some work in "feedback" systems may well be started in the near future.

#### 4.8. Design Management

HBF of ETH-Z has been active for some time in a project on design management functions, considering resources, time, cost, and other factors.

A state-of-art study of Swiss design management practices was completed and showed great differences in management methods and philosophy between not only larger and smaller offices, but also between offices of similar size. In general, only the large offices have any organized method for design management, and these use individually developed methods. The study of present practices also involves a comparison with British practices (the project architect being a British subject).

In a second stage it is planned to analyze in depth all phases of design management, design philosophy, and possibly applicable management systems and methodology from other areas of human endeavor. Among other approaches, the application of network management techniques and computer based design aids will be studied and evaluated.



#### 4.9. Building Accoustics

Projects in the area of building accoustics include studies of the fundamentals of accoustic performance of buildings and applicable measurement techniques, and the development of a method of test for the sound attenuation of windows. The purpose of this method was specifically the evaluation of windows intended for applications in proximity to airports and runways. The development of a new method of test was needed because it was found that the sound attenuation performance of exterior elements such as windows can not be properly evaluated with the methods commonly used for interior partitions or doors, as the sound from exterior sources is directed, while the sound from interior sources is dispersed. This work was developed at EMPA where also at present the only available test equipment is located.

#### 4.10. Testing and Certification

Switzerland does not at present have an agrément system for the evaluation of innovative building systems, components, and materials. However, EMPA does both certification and testing, and its certification is accepted in general by building regulatory agencies.

In the testing area, EMPA has been active both in steel and in concrete and masonry construction.

Of direct interest to the building construction industry is the work in the development of a sampling method for evaluating concrete in completed structures. The method consists of extracting small cores by boring similar to the methods used for evaluating soil and rock conditions. The new method has the advantage that the sampling process does not generally weaken the structure as only small diameter cores are extracted, and that it is possible to extract several samples from even small concrete building parts. The reliability of the method is admitted to be somewhat inferior to the conventional cylinder test methods (in Switzerland, conventional concrete testing is conducted on cubes), but still within acceptable limits consistent with the approximate nature of the design assumption and the inherently large material strength tolerances, particularly since the small specimen size permits a greater number of samples to be tested.

Also in the area of concrete construction is the evaluation of aggregate quality, particularly its purity. Although the importance of using high-grade quality aggregates without impurities is recognized, it is also recognized that often lower grades or impure aggregate have to be used. EMPA is doing both research and service work in this area.

The work at EMPA on the performance of masonry compression members is well known and is discussed in the open literature.

In the certification area, EMPA and, to a lesser degree, some of the Institutes at EPF-L are strictly using "spot-check" methods. No compliance or quality control activity is involved.

#### 4.11. Transportation

Although transportation is not generally considered part of housing or building research, it is part of planning and thus related to the question of housing.

Switzerland has traditionally had a good public transportation system and the high population density is contributing not only to the maintenance of the existing system but to its expansion. Accordingly, research in urban transportation appears well developed, for example:

On the technological level, EPF-L is active in the development of entire transportation systems and of innovative motors for such systems. EPF-L also is cooperating with U. S. agencies working in this area. More details of this cooperative program are given in the discussion of EPF-L and its Institut of Transportation Technology.

On the planning level, Battelle Institute is developing a comprehensive transportation plan for the City and Canton of Geneva.

#### 4.12. Building Laws and Codes

Current and completed work in this field can be divided into separate but interrelated areas:

Research is being conducted into the legal and constitutional aspects of building laws and codes with the objective to determine the state-of-art and the means for influencing the development of changes and revisions possibly required.

State-of-art studies of the technical content of the laws and codes to determine both differences and similarities in the various codes.

Studies to determine the effect of legal and code restrictions on building construction, particularly in regard to economic (cost) effects, and directed towards industrialized building construction.

In regard to the third of these research areas, the research conducted so far is said to indicate that little evidence exists to substantiate the belief that building laws and codes constitute a major constraint on building activity or industrialized construction, nor that laws and codes substantially affect the building cost. It was further found that many objections to the multiplicity of codes are in fact objections to the

higher requirements in some codes, and that a unification of the codes at the higher performance level would not answer this criticism. Several comments made by architects and other knowledgeable persons to this investigator appear to substantiate the findings of these research studies conducted by various ad hoc groups under the sponsorship of FKW.

#### 4.13. Legal Aspects of Rental Housing

According to Swiss law, the renter has no rights on the property itself. For example, if an owner terminates a lease, the renter can only sue for damages, but not for return of the rented object, nor for reinstatement of the lease. Various forms of relief in the area of apartment leases are in effect since World War II, however, these were established as temporary measures and have not altered the legal basis. New socio-economic facts and standards are now pressuring for fundamental legal changes. The project objective is to investigate the present legal situation in Switzerland and selected foreign countries (under others also the United States) and to propose possible solutions based on new legislation or regulation at either federal, cantonal (state) or local levels.

The project is conducted at IREC of EPF-L.

#### 4.14. Organization of Building Research

Sponsored by FKW and in cooperation with other organizations (CRB) and individuals, Battelle Institute - Geneva, is currently developing proposals for a "model" of future Swiss building research activities. The first phase of this project includes a detailed investigation of present Swiss practices, foreign practices, and tentative suggestions for alternative organizational structures. The first part parallels closely the study of Swiss building research activities conducted by this investigator, but will be more detailed and in greater depth (the Battelle Institute contract sum for this part is SFR 68,000 (\$20,000)).

In a preliminary report issued by CRB to document the need for the above study, it is claimed that today's Swiss building research activity is inadequate and that this opinion is held by most persons active in the building industry. Specifically the following insufficiencies are mentioned: Too little research; research not coordinated; lack of interdisciplinary research orientation; lack of educational opportunities for building researchers. According to these inadequacies, the preliminary CRB report not only demands a restructuring, but also advocates a substantial increase of the research activities.

#### 4.15. Literature and Documentation

Most formal research reports are published by one or more of the following organizations:

Forschungskommission Wohnungsbau (FKW)

Institut fuer Rationalisierung im Bauwesen (CRB)

Schweizerischer Ingenieur und Architekten Verein (SIA)

The sponsoring organization is not always the publishing agency if publication by an other organization assures a wider distribution.

This investigator has collected a great number of research reports and other publications. In addition, a number of abstracts and several literature lists (bibliographies) were obtained. With few exceptions this material is either in German or French, and will be incorporated in the CBT Library.

## 5. SUMMARY AND DISCUSSION

Within the limitations of a two week visit to Switzerland, a good understanding was gained of that country's building research activities. The information obtained in various interviews was supplemented by a brief study of the literature collected during the trip, and this report reflects both sources.

Considering the size and resources of Switzerland, the country is very active in building research. This activity is considered a vital and integral part of the total effort to improve the housing situation. The activity also appears well coordinated and directed by the Swiss Federal Commission for Housing Research (FKW).

The single research projects are conducted by private, educational, and non-profit organizations under federal contract to FKW. The projects concern mainly the "software" aspects of the socio-economic housing research areas. Substantial research is reported in the civil engineering areas, but Swiss usage does not consider such research as part of housing research. While both housing related "software", and engineering "hardware" research is well developed, the interdisciplinary link between the two areas is developed to a lesser degree.

With regard to a possible cooperative program between CBT-NBS and appropriate Swiss institutions, it appears that the American agencies would most profit from work in the areas of both socio-economic "software" and engineering "hardware". On the other hand, Switzerland may wish to consider cooperative work related to the link between the above "software" and "hardware" areas.

APPENDIX 1

Trip itinerary:

November 20, 1972 - Zurich

Institut fuer Bauberatung  
Baudata Systematik (BDS)  
Eidgenoessische Technische Hochschule (E.T.H.)  
Karl Steiner AG, General Contractors

November 21, 1972 - Zurich

Institut fuer Hochbauforschung (HBF)  
Institut fuer Bauplanung und Baubetrieb (IBB)  
Schweizerischer Ingenieur und Architekten Verein (S.I.A.)

November 22, 1972 - Zurich, Binz

Institut fuer Rationalisierung im Bauwesen (CRB)  
Ernst Goehner AG, Builders and Developers  
Mr. H. Litz, Architect

November 23, 1972 - St. Gallen

Schweizerisches Institut fuer Aussenwirtschafts-,  
Struktur-, und Marktforschung

November 24, 1972 - Bern

Eidgenoessische Forschungskommission fuer Wohnungsbau (FKW)  
Mr. Ed. Helfer, Architect

November 25, 1972 - Bern

Eidgenoessische Forschungskommission fuer Wohnungsbau (FKW)

November 27, 1972 - Bern

Eidgenoessische Forschungskommission fuer Wohnungsbau (FKW)

November 28, 1972 - Carouge, Genf

Battelle Institute  
Delegation du Logement

November 29, 1972 - Bern, Basel

Planning Department of the City of Bern  
Suter and Suter, Architects

November 30, 1972 - Lausanne

Ecole Polytechnique Federal - Lausanne (EPF)  
Institut de Recherche Pour l' Environnement Construite

December 1, 1972 - Duebendorf

Eidgenoessische Materialpruefungs - Anstalt (EMPA)

## APPENDIX 2

Names and addresses of organizations and principal contact.

Battelle Institute  
Rte. Drize 7  
Carouge, Switzerland  
Dr. M. Boerlin, Project Manager<sup>1</sup>

Bauberatung, Institut fuer  
Meyerstr. 14  
8002 Zurich, Switzerland  
Mr. H. Held, Director

Baudata Systematik (BDS)  
Meyerstr. 14  
8002 Zurich, Switzerland  
Mr. H. Held, Acting Secretary

Bauplanung und Baubetrieb (IBB), Institut fuer  
Fliederstrasse 23  
8006 Zurich, Switzerland  
Prof. A. Pozzi, Director.

Delegation du Logement  
Rue des Granges 5  
Genf, Switzerland  
Mr. P. Gilliland, Director

Ecole Polytechnique Federale - Lausanne (EPF)  
Av. de Cour 33  
1007 Lausanne, Switzerland  
Prof. Dr. M. Cosandey, President

Eidgenoessische Forschungskommission fuer Wohnungsbau (FKW)  
Weltpoststr. 4  
3003 Bern, Switzerland  
Dr. G. Koehn, Secretary

Eidgenoessische Forschungskommission fuer Wohnungsbau (FKW)  
Schosshaldenstr. 22A  
3006 Bern, Switzerland  
Prof. J. W. Huber, President

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<sup>1</sup>Dr. Boerlin is reported to have been appointed Director of IREC (EPF-L) in Spring, 1973.



Eidgenoessische Materialpruefungs - Anstalt (EMPA)  
Ueberlandstr. 129  
Duebendorf, Switzerland  
Prof. Dr. T. H. Erisman, Director

Eidgenoessische Technische Hochschule (E.T.H.)  
Department of Architecture  
Leonhardstr. 33 E  
8006 Zurich, Switzerland  
Mrs. T. Hetzler, Assistant to  
Prof. v. Gunten, Department Head

Goehner AG, Ernst, Builders and Developers  
Hegibachstr. 47  
Zurich, Switzerland  
Mr. R. A. Rietiker, Vice President

Helfer, Mr. Ed., Architect  
Kasthoferstr. 31  
Bern, Switzerland  
Mr. Ed. Helfer, Principal

Hettich, Mr. U., Architect  
Thunstr. 95  
3006 Bern, Switzerland  
Mr. U. Hettich, Principal

Institut fuer Hochbauforschung (HBF)  
Nelkenstr. 11  
8006 Zurich, Switzerland  
Prof. H. Kunz, Director

Litz, Mr. H., Architect  
Benglen-Fallanden  
8122 Binz, Switzerland  
Mr. H. Litz, Principal

Planning Department of the City of Bern  
Schwarztorstr. 9  
3003 Bern, Switzerland  
Mr. H. Graf, Chief Planning Section

Institut fuer Rationalisierung im Bauwesen (CRB)  
Sumatrastr. 15  
8006 Zurich, Switzerland  
Mr. H. Joss, Director

Recherche Pour l' Environnement, Construite (IREC)  
Institut de  
61, Av. de Cour  
Lausanne, Switzerland  
Mr. M. Y. Maystre, Acting Director<sup>1</sup>

Schweizerischer Ingenieur und Architekten Verein (S.I.A.)  
Selnastr. 16  
8039 Zurich, Switzerland  
Mr. C. Reinhard, Chief, Standards Publication

Schweizerisches Institut fuer Aussenwirtschafts-,  
Struktur-, und Marktforschung  
Dufourstr. 48  
9001 St. Gallen, Switzerland  
Mr. R. Jeker, Assistant to Prof. A. Nydegger, Director  
of the Institute

Steiner AG, Karl, General Contractors  
Oerlikon, Zurich, Switzerland  
Mr. X. Bezozzi, Vice President

Suter and Suter, Architects  
Engelgasse 12  
400 Basel, Switzerland  
Mr. M. Ritter, Chief, Dept. of Housing Construction

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			14. Sponsoring Agency Code		
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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)  Following up earlier contacts of CBT management with representatives of Swiss building research organizations, the author visited Switzerland in the Fall of 1972 for two weeks.  This report discusses the results of meetings with representatives of the Swiss Federal Commission for Housing Research (FKW), major educational and research establishments, architects, contractors, builders, and local building officials. Topics covered in the discussions included building economics, modular coordination, pre-evaluation of performance of housing projects, pre-evaluation of research projects, building design, land use and planning, transportation, and building laws, codes, and standards.  It appears that cooperative programs in any or all of these areas could be profitable to NBS, and to the corresponding Swiss organizations.					
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