SESSION B

Tendering and Contracting

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The Japanese Way of Tendering and Contracting

Pratiques japonaises dans la soumission et l'adjudication

Japanische Formen der Ausschreibung und Vergebung

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SUMMARY

In Japan, a number of large scale structures including skyscrapers are still being constructed, despite the fact that Japan apart from having extremely congested cities lies in an earthquake zone. Systems of safety and quality assurance for building structures are an integral aspect of Japanese building practises. One aspect of the quality assurance system is the Tendering and Contract System in Public Works Construction.

RÉSUMÉ

Un grand nombre de constructions importantes, dont des gratte-ciels, continue à être réalisé au Japon, ce pays est caractérisé par des zones urbaines très larges et par une activité sismique intense. Les systèmes de sécurité et d'assurance de la qualité des constructions de génie civil font partie intégrante des pratiques japonaises de la construction. Un élément de cet ensemble est le «Système de soumission et d'adjudication pour les constructions d'intérêt général».

ZUSAMMENFASSUNG

In den eng überbauten und durch Erdbeben gefährdeten Städten Japans wurden und werden bedeutende Bauwerke, unter ihnen auch Hochhäuser, gebaut. Die Anwendung von Systemen für die Gewährleistung von Sicherheit und Qualität sind ein integraler Teil japanischer Baupraxis. Dazu gehört auch das System von Ausschreibung und Vergebung, welches bei der Erstellung öffentlicher Bauwerke Anwendung findet.

1. FEATURES OF CONSTRUCTION INDUSTRY IN JAPAN

1.1 Preface

In September, 1985, an earthquake of the magnitude 8.1 occured along the pacific coast of Mexico, in the capital, Mexico City, located almost 400 Km from the seismic center, over 5,000 people were killed, and a considerable number of buildings destroyed.

Japan, like Mexico, is located in an earthquake zone, and as a result, subject to frequent earthquakes of various magnitudes. This poses special problems in the field of construction and has led to the development of a sophisticated aseismatic technology, which combined with Japan's unique "social system", makes it possible to construct skyscrapers, nuclear power plants, suspension bridges, inground LNG tanks and other such projects.

The intention of this article is to explain a portion of that unique system associated with "safety and quality assurance" of large structures, specifically the bidding and contract system utilized in public works in Japan.

1.2 Aseismatic Technology

Aseismatic engineering knowledge helped to develop the first skyscraper in Japan, the Kasumigaseki Building was completed in 1968, since then numerous skyscrapers have been constructed. The history of aseismatic engineering began 95 years ago, with the Nohbi Earthquake. The earthquake caused extensive damage to those structures and bridges which had been constructed utilizing newly introduced European technology. The result was more attention being forced on the seismic forces affecting construction. The Great Earthquake of 1923 in the Kanto district, and the resultant widespread destruction, led to the incorporation of various standards and specifications in construction, where safety for human life and building structure became major considerations. At that time, Japan became the first country to incorporate into statutory form, aseismatic regulations in the field of construction; other countries, such as the U.S.A. would soon follow suit.

In the years after the war, the construction industry, saw more development in the field of aseismatic technology. In 1981, the revision of the Enforcement Ordinance of the Building Standards Act introduced a new aseismatic design method.

1.3 Industrial Characteristics of the Construction Industry

As it is well known, the construction industry has industrial characteristics which differ from those of other industries. The first characteristic is that of an order receiving contracting business. Business is maintained only through orders for construction. The second characteristic is that of a single production at a different location. The scale and type of construction, as well as the site and location varies at all times. Unlike a general commodity a structure is not interchangeable with another. The third characteristic is that construction is an outdoor and weather oriented industry therefore profitability is greatly affected by natural conditions and local environments. The fourth is it is a labour intensive comprehensive industry which relies largely on subcontractors, suppliers and manufacturers. As well the construction industry must organize subcontractors, supplies and manufacturers to ensure accurate and efficient delivery of products for construction.

1.4 Cultural and Construction Differnces

Historical Japanese architecture and engineering works, manifest in Shinto Shrines, Buddhist temples, embankments and roads, demonstrate some basic cultural and construction principles in Japan. Japanese culture places nature in an esteemed position a place of prominence, Japanese culture is sympathetic to nature. The construction as a result does not fight against nature rather it only protects from nature. In Europe and America it was not possible to try to achieve this balance with nature, the extremes of climate made it necessary to conquer in order to maintain human existance. Consequently, natural science and structures were made to forcibly cope with nature. The difference between the West of keeping harmony and order usually by means of contrast and the Japanese way of depending on mutual fiduciary relations dependant upon mutual good faith can be said to be atrributable to the substantial difference in the philosophy and culture.

In spite of such differences, Japan since the Meiji era has followed Western patterns, in preparing similar laws and regulations governing construction. However, a Japanese-manner of application has been kept regardless of the Western origins, thus the following problems have resulted. That is, in the process of hastened modernization during the Meiji ear, such a relation was created that the government as the orderer dominated contractors with power, and the latter was only to obey the former. A trace of such a relation is still reflected on the operation of the bidding and contracting system at present, and an owner and a contractor are not always in an equal position.

2. PREQUALIFYING PROCEDURE

2.1 Licensing System for Contractors

To do the business of contracting for construction, one has to obtain a license under the Construction Business Act. The following requirements must be met by a construction company in order to obtain license.

(1) Business managers on staff
(2) Full time staff engineers
(3) Sincerity in fulfilling a contract has been recognized.
(4) A base of assets or monetary credit exists, sufficient to support the execution of contracts.

It is the first condition for a contractor to meet the above requirements. If a constractor violates other laws related with its business or acts unfaithfully with regard to a contract, he will be punished under a provision of the Construction Business Act.

2.2 Application for Nomination and Prequalifying Procedure

A contractor has to send in an application for nomination for works, in advance, to a government agency where he wishes to tender. This application is made on the basis of the applicants' business status on the beginning of a year. The government agency giving orders classify contractors into three to five grades by examining their means, credit, results of works, performance of safety, and other points. After this classification, work assignment is determined, and the contractors engage in promotional activities while waiting for a nomination from the government agency.

3. BIDDING SYSTEM

3.1 Nomination of Contractor Qualified for Participation in Bidding

Competitive bidding is fundamentally applied to bidding for government works. The principle of competitive bidding is regulated by the Local Government Act. There is general competitive bidding and competitive bidding by specified bidders. The majority of the bids are of the latter kind. When competitive bidding by specified bidders is required for a work, the nomination committee from the Government will determine the bidders according to the nomination standards and also considering the past record of nomination and awarding contracts. If a tenderer on examination is found to have an unstable credit in business, past defective work or injury causing accidents, he may have difficulty receiving a nomination from the nomination committee. A strict examination is made for a bribery case, death from accidnet during work and the like, and those who have committed such failures will be unable to receive a nomination for a certain period.

3.2 Notification of Construction Work

Upon notice of nomination from the owner, a planned work is made public, and documents such as design drawings, construction specifications and condition of estimate are presented to the nominated constructors.

Calling the nominees to the site office, detailed explanation is made of the work with the specifications and drawings issued by the owner, as well an on-site briefing and inspection is made.

Following the site briefing, the nominees make a close study of the specifications (common, special, additional) and drawings. During preparation of the estimate if points are found to be unclear, a questionnaire of these points is assembled and submitted to the orderer. The owner prepares answer sheets for the nominees.

Then, each of the nominees make a further survey of the site, calculate the quantities, the execution plan, setting of unit prices, and prepares in detail, statements of direct construction cost, temporary work expenses, machinery and equipment cost and indirect expenses. The final estimate is determined when general and administrative expenses, interest and profit are added to the preceding costs.

3.3 Tendering and Awarding Contract

Since a government agency is restricted by its budget, it sets a "predetermined maximum price" for bidding. This, a common characteristic in Japan, is the price of the work where a standard contractor does the work by reasonable methods, and the price by the successful tenderer should not exceed it.

Immediately after receiving the tenders the opening is made by an officer-in-charge in front of the tenderers. The intent of awarding the contract is indicated to the lowest tenderer within the limit of the predetermined maximum price, and a contract is made with the tenderer. If the price is exceeded, bidding is performed once again. If the limit is still exceeded after bidding is repeated a few times, negotiations are made between the lowest tenderer and the owner. This step may lead to the award of the contract, but there are cases where the procedure of a free contract results in an agreement.

4. CONTRACT SYSTEM

4.1 Contract and Quality Assurance

When selection is made of a successful tender or a negotiation, a construction contract is concluded. The contract documents include the contract, conditions, design drawings and specifications (which include the site briefing sheets and the question & answer sheets) the last two being called design documents. The contract is effective and binding when it is signed by both parties. The Construction Business Act provides that the owner and contractor should reach agreement on a fair contract on an equal footing and perform it with faithfulness and sincerity. The contract mentioned above sets forth the title of work, the term of work, the contract price and other main items, while the conditions show the clauses regarding the rights and obligations of the parties that can be standardized. The design documents express technical matters and those concerning quality in the concrete for the execution of the work. These contract documents are the only arrangements binding the parties with legal effects.

Actually, for public works, Standard Contract Conditions for Public Works are employed as a rule for conditions of a contract for work. These conditions, comprising 47 articles, lay down the contents of work, its term, contract price, advance payment, partial payment, completion, delivery of work, altering conditions, damage due to force majeure, change of the contract price owing to fluctuation of wages and prices, guarantee of the contract, a warranty, and others.

As well, there is the Standard Subcontract Conditions for Construction Work (A, B) which is the conditions for subcontract works. From the standpoint of structure, safety, and quality assurance, there seems to be few problems between the contracting parties. As previously stated one of the characteristics of the construction industry, is that an owner cannot freely select a product such as ordinary commodities. Requirements on quality are specified in the design documents, as well part of the quality achieving process should be indicated by the owner.

Furthermore, technical restrictions are imposed by laws and regulations. The level of quality to be achieved on a structure is often demonstrated in the form of requirements from the owner to the contractor. The requirements include a clause to check completed work by inspection, but it is extremely difficult to secure quality only through inspection. At the time of concluding the contract, therefore, the method of execution of works and the control method are provided as requirements.

4.2 Kinds of Contracts

The blanket contract is an ordinary contract to undertake the total work to complete the construction. The separation contract applies to those cases where building construction, is divided into construction segments such as air conditioning equipment, electric work and others, and separate orders and contracts are made for each item.

The lump sum contract is a method to fix the total amount of construction price, which is used almost always in Japan. The cost-plus-fee contract method is used where there are many uncertain elements in the work and the structure must be properly completed.

4.3 Start of Construction

As soon as the contract is signed, the owner and the contractor take the necessary steps to execute the contract. The owner sends the contract to a guarantor to insure completion, and notifies the contractor of the supervising engineer. The contractor submits to the owner notices of comencement, the site representative, senior engineer, supervisory engineer and technical experts, and work progress schedule and application for approval of subcontractors, for the owner's approval.

Before the start of construction, the contractor understands the contents of the construction through the design documents, submit a concrete execution plan for details of tentative constructions, procedures and working methods to get them examination by the supervisors.

5. PROBLEMS AND PROSPECT

5.1 Equal Footings in Contract and Its Rationalization

Japanese, regard the concept of contracts in an historically different manner than the West. Though they have prepared similar laws and systems as the Europeans and Americans they have applied such laws and systems in a Japanese manner. In spite of such application, they have functioned relatively well and led to the completion of large-scale projects.

As to the long term relationship developed under the owner's leadership, where the contractor is controlled by the owner's intention and obeys the owner, a question should be asked as to whether it is desirable or not for us to continue to take advantage a Japanese characteristic which does not discern a qualitative distinction of the contractual right and other obligations. In order to break the isolation of the domestic construction industry and to comply with diversification, progress in other technologies and the internationalization of the world, a unilateral contract should be established to achieve equal positions in contract. The concept should be reformed for those people concerned towards a clarification of the contents of a contract which would be suitable for an improved contract system.

5.2 Business Efforts and Predetermined Maximum Price

In Japan, perfectly free competition is prevented by the fact that a contract cannot be concluded where the bid price is higher than the predetermined maximum price.

Only recently some owners have come to develop a more flexible idea of the sytem in order to make the best positive use of contractors' technologies such as VE in the U.S.A. and the bidding for alternatives in Europe.

Viewed from the aspect of technical development, a new and superior technology may fail to have a better chance at present in governmental works owing to restrictions of the present contract system.

5.3 Specialization and Transmission of Quality Information

In Japan, there was a tradition of superior technology used for the Golden Pavillion of the Horyuji Temple, the world's oldest wooden building, and the large-scale Temple of the Great Image of Buddha in Nara.
Today, technologies of European-like architecture introduced from the West have been playing a major role based on the characteristics of science and modernism.

The general trend in high-technology indicates a further specialization of "jobs". In the stages of planning, designing, construction and use which form a continuous flow to create a structure, information on quality and function is apt to be separated.

Since Total Quality Control (TQC) was introduced into the construction industry, comparatively detailed discussions have been made on quality assurance through TQC acitivites. One of the subjects is the transmission of quality information. In quality assurance, two flows of information are important, one is the information of the desired quality to each of the following stages of work. The other is the feed back of claims from the following stages including the use to the various stages of the process.

An improvement activity carried out solely by a contractor in his position may be just good enough to make a minor improvement of irregularities in work. To make broad service of a constructions in society, it will be indispendable to establish a data base of quality which can commonly be utilized by government agencies, which are owners and administrative organizations, academic institutes, designers, consultants and contractors.

We would like to make a contribution to the creation of a more sophisticated living environment for the 21st century by correcting the inequality in the bidding and contracting and also by mutually understanding the owner's and contractor's roles.

Planning, Management and Quality Assurance in Civil Engineering

Concept, gestion et assurance de la qualité dans le génie civil

Planung, Leitung und Qualitätssicherung im Bauwesen

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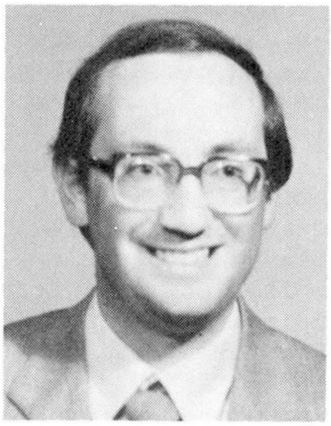

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SUMMARY

The system of management in civil engineering in Czechoslovakia is briefly described. Basic facts about contracting and the procedure awarding for contracts in socialist countries are given and the way to improvement is discussed. The main principles of the system of contractor's preparation of building production, which has been developed recently, are determined and the way to apply it in practice is indicated. The functions of subsystems for creating and balancing the production programme of a contractor and that for automatic elaboration of construction technology projects are emphasized.

RÉSUMÉ

Le système de gestion des constructions en Tchécoslovaquie est passé en revue. Les principes de base de l'adjudication des travaux de construction dans les pays socialistes sont présentés ainsi que leurs possibilités d'amélioration. L'article présente les bases systématiques – developpées récemment – de la préparation du travail, ainsi que des applications pratiques. Il souligne l'importance fonctionnelle des sous-systèmes pour la création et l'équilibre des programmes de production de l'entreprise et pour l'établissement automatique des documents de projets de construction.

ZUSAMMENFASSUNG

Die im Bauingenieurwesen der Tschechoslowakei üblichen Methoden des Managements werden beschrieben. Die in sozialistischen Ländern bei der Vergebung und Vertragsgestaltung angewendeten Grundsätze sowie auch Verbesserungsmöglichkeiten werden vorgestellt. Der Beitrag beschreibt die kürzlich neu entwickelten Prinzipien der Arbeitsvorbereitung und zeigt ihre praktische Anwendung. Schliesslich wird auf die Funktion von Subsystemen für die Entwicklung von Produktionsprogrammen und für die automatische Erstellung von Projektleitungs-Dokumenten eingegangen.

1. INTRODUCTION

When new projects have to be undertaken it is necesarry to visualize all the operations of the projects, arrange these operations in their proper sequence, achieve confidence that every participant of the building process, that means the investor, the architect and the contractor understand each of his tasks, aquire the know-how and means necesarry to perform them and feel convinced that the method thought out for performing all tasks is the most progressive and economical. Thus all projects have to be efficiently planned at the investor´s, architect´s and contractor´s sides. The quality assurance plan is one of the main parts of such a plan.

Especially in socialist countries including Czechoslovakia proper planning and balancing of the building process of all structures plays a vital role because all management of the national economy is based on the state plan. The main sign in socialist economy is the social ownership of all means of production. All enterprises, firms, factories and establishments are owned by the state and their production is thus directed. No private persons are entitled to undertake. Main tasks of all firms including building enterprises are stated in the five year economic plan which is worked out by the State Planning Commitee. This commitee determinates in global the mass of production of every building firm and the mass of financial means given to different investors (e. g. firms from other branches, national commitees etc.). In this process these financial means (the investment capital) of all investors are balanced with regard to the production possibilities of all civil engineering firms. The approved five year plan is updated and defined with more precision every year.

There are lots of differences between the building process management in socialist and capitalist countries. In socialist countries there are standart prices for construction works in building industry as in other branches. The average contractor´s firms are usually bigger with approximately 8000 - 9000 emploees and those with similar production programme are associated into so called production-economical units what is a sort of a trust. The trust is directed by the general management with the director general as its head. All trusts in building industry are then directed by the Ministry of Civil Engineering.

Global tasks determinated by the state plan for the civil engineering branch are divided by the Ministry to different trusts according to their sort of production and production capacity by stating the global financial volume of total production per time period (5 years, 1 year). The planned financial volume of production of individual enterprises associated in the trust are determined by the general management of the trust according to the size of different firms.

Similar process of dividing financial means for investment appears at the investor´s side. The investment capital can be given not only from the state institutions (e. g. State Planning Commitee, Ministries and other institutions of the government etc.) but from the means of different other firms gained by their production and profit as well.

Though at the peak level of planning the sum of investment capital is balanced with regards to the production capacity of the civil engineering branch conflicts between claims of individual investors and production possibilities of individual contractors may occur at the level of concrete contracts negotiations. As the volume of investment capital is rather high in Czechoslovakia the investors´ requests for construction works is usually higher than the production capacity of a construction firm, especially in structural engineering. Claims and production possibilities have been recently in harmony in transport, bridge and waterwork engineering in Czechoslovakia.

Recently a new method of balancing the production programme, planning and management of constructions with respect to their quality assurance has been developed in our research establishment. The main purpose of the method is to increase the production capacity of the enterprises of our trust and the resulting quality of buildings by improving the utilization of all resources (as manpower, machines, fuel, material and capital) and by simulating and balancing the consumption of those resources in different variants of production programme from the five year plan level in the whole trust, one year plan level in the trust and in the individual enterprises till to the operational level of management of construction processes on sites. According to the method a system of contractor´s preparation of building production has been worked out. Some parts of the system are used in practise by now, other parts are still in the research stage.

2. PRINCIPLES OF THE SYSTEM OF CONTRACTOR´S PREPARATION OF BUILDING PRODUCTION

The aggregated flow chart of the system is shown on Fig. 1. The system consists of 6 main subsystems: creation of the 3 - 5 year production programme of the contractor, creation and optimization of the 1 - 2 year production programme, automatic elaborating of basic documents of construction technology projects at the level of construction technology studies, construction technology conceptual projects (CTCP) and construction technology operational projects (CTOP) and production control. The main principle of the system is to ensure the optimal process of production of a contractor´s firm with respect to certain given conditions that would lead to fulfilment of all tasks of the individual enterprises and of the whole trust.

The system can be divided into three time levels: planning and creating the production programme with respect to investors´ intentions and construction technology studies for the period of 3 - 5 years, production programme with respect to more precious investors´ requests and construction technology conceptual projects for the period of 1 - 2 years and operational planning and production process control with respect to construction technology operational projects for the period of 3 months to 1 year. Every subsystem on higher time level has significant relationships to subsystems on the lower time level and vice versa. The main feedback comes from the actual course of the production process on site and has a significant influence on time plans of erection of buildings. It must respect casual delays or condition changes that occur on site. This feedback leads to the automatic modification of basic documents of construction technology operational projects, to alteration of the operational plan and helps to find optimum measures to compensate the delays etc.

The main inputs into the system are: investors´ intentions at the side of production programme creation, architectural designs and projects at three levels of detail (structural studies, introductional projects and operational structural projects) at the side of construction technology project elaborating. External influences and technological progress have effect especially on the databases of technical and economical indexes that respect the recent data about productivity of labour, prices of construction works, time standarts etc. The main output from the system is the technologically realizable five year plan and one year plan that should correspond with plans given by the state authorities.

Practically all operations in the system are to be computerized. Nowadays the computerized subsystem of creating and financial balancing of the production programme comprising awarding works and contracting procedure and subsystems for automatic computerized construction technology designing including elaborating and optimizing technological standards, network diagrams, line-of-production graphs, bar charts, resource needs diagrams, automatic budgeting and estimating are in full use. Recently new programs for dispatcher's production control and operational filing of the actual state of site production with the relationship to automatic updating of construction technology operational projects have been developed and are in experimental use.

Therefore further parts of this contribution are dedicated to explainig the procedure of contracting and awarding works with the help of the system and to illustrating the automatic creation, optimization and updating of the basic documents of construction technology projects with respect to quality control and assurance and to the actual course of construction processes on site.

3. PRODUCTION PROGRAMME CREATION

3.1 General conditions

Contracting or awarding works procedure at a building firm in socialist countries is based on selecting structures and buildings which should be built in the years to come according to the investors' requests, production possibilities of the contractor and the state plan while respecting the significance and priorities of planned structures. The investors' requests are usually higher than the contractor's production capacity. The contractor may then choose works that are advantageous for him but he has to respect the investors' interests given by the state plan. The selected structures create the production programme of the contractor. According to the approved production programme contracts with the investors are drawn up. As prices for construction works are the same at all firms in Czechoslovakia no tendering or bidding as in western countries take place. The process of bidding comes true when exporting investment units abroad. Then the procedure is much the same as in other countries.

In Czechoslovakia there exist a central computerized database of all structures that are to be built in next 5 years or that are being built. Every contractor has his own files of data about his structures which include especially: name and place of the structure, term of planned start and finish of the erection, planned budget costs and planned and actual financial volume of the annual production for all years of erection. This database is updated by all contractors twice a year at the occasion of negotiations between the investors and the contractors when so called contractor - investor relations (CIR) are determined (see Fig. 1) and the production programme is actually created. These negotiations proceed in two stages (CIR1 and CIR2). In the first stage possibilities of building new structures for the next 5 to 3 years are investigated according to investors' requests and free production capacities of the contractor in the coming time period. In the second stage the requested tasks for the coming year are determined more precisely and agreed both by the investor and contractor. The agreement has been made only on the basis of financial volume of the year's production at the contractor's side since. Therefore only finacial comparison of the total annual production programme with total production capacity of the firm can be done. So far this balance has not included technological points of view, e. g. number of workers of different crafts, number of different machines available, production possibilities of concrete and panel plants, fuel consumption etc. In most firms the database updating has been done on a big computer after all negotiations were over, that means that in the course of negotiations the contractor's agents have to balance the actual production capacity and the investors' requests "by hand". The number of structures at an average building firm in Czechoslovakia is about 800 - 1200 all of which have to be negotiated.

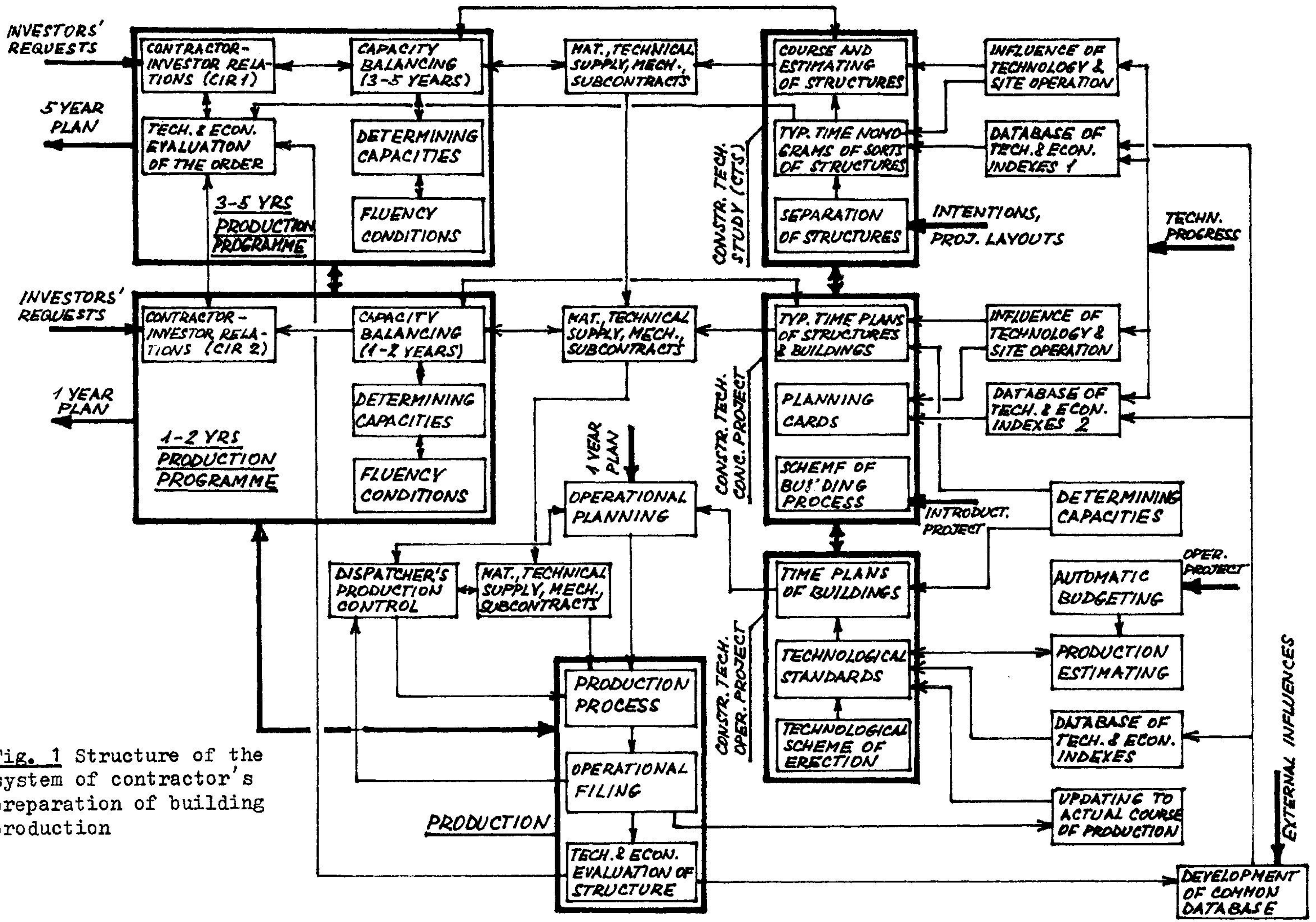

Fig. 1 Structure of the system of contractor's preparation of building production

3.2 Improvement of the contracting procedure by the system

The proposed system of contractor's preparation of building production has brought into the contracting procedure two main improvements.

When the contractor - investor negotiations are in progress the data about structures of a building firm are transfered from the central database into a microcomputer. The microcomputer serves to the contractor's agent to updating the financial volumes of production that were agreed in the database continuously in the course of negotiations directly. There is a possibility to balance the total financial volume of the requested production with the actual production capacity of the firm at every moment of negotiations and thus to make corrections necessary for the balance to be in harmony. As stated higher the investors' requests are in most cases higher that the production capacity of the firm. The system helps to find the time interval when the production capacity is free for beginning the construction process. If the 1st stage of this negotiations comes to the agreement the structure requested to be built is put into the database of the production programme, terms of start and finish are stated and the contract is drawn up. The 2nd stage of CIR proceeds in similar way, only the financial volumes for the period of one year are stated more precisely.

If there is a conflict between the request of an investor and the interests of a contractor (e. g. because of overfilled production capacity) it has to be solved at the level of the trust's general management. The agents at this level are entitled to correct the firm's intentions so that the production programme of the entire trust could be in harmony. This procedure based on microcomputers is in full use in our trust now /5/.

The basic principle of the second main improvement of the contracting procedure is in balancing not only financial volume of structures requested by the investors but other technological resources too, e. g. labour force in special crafts, needs of basic sorts of material and fuel etc. When the investor comes to the building firm with his request he naturally does not know anything about the needs of technological resources, he knows usually only the approximate financial cost of the proposed project and some facts about what purpose the complete building should serve to. In order to state the start and finish of the erection of the structure as precisely as possible the contractor should know his production possibilities in the future not only from the financial point of view but especially from the point of view of technological resources in the very first phase of the negotiations. This significant knowledge should comprise all facts about the balance of technological and finacial resources in next 5 years for erecting all structures that are being built or are to be built. The proposed subsystem that is now being created should enable to have this view at the contractor's fingertip on the microcomputer.

The subsystem will consist of a database of models of the course of the building process of different sorts of typical buildings and structures that are most common in the production programme of the contractor. It will comprise the typical network diagram of the erection and on that basis it will be possible to simulate the production and to find the moments of starts and finishes of significant construction processes and thus the needs of technological resources in the course of time and to optimize them. These simulated data will be defined with more precision as soon as more precised facts about structures are available, e. g. when architectural projects are ready, or construction technology projects are worked out, or according to the actual course of construction processes on site. Thus it will be possible to find the free production capacity at the earliest possible moment. This would enable to satisfy most contractors at the earliest time.

On the other hand the proposed subsystem will be able to optimize the advancement of specialized work gangs on several building sites, the resource allocation for most significant projects or find the optimum progress of erecting several structures according to the main limited resources at the contractor's disposal by using optimum resource allocation methods and resource leveling procedures described e. g. in /1/, /6/ and /7/. Conditions of the fluency of construction processes, machines available etc. are naturally taken into account. By using this subsystem it will be possible to allocate the main resources in the optimum way in order to fulfil the state plan and the investors' requests and to prepare the conditions for optimum production for all plants and sites of the contractor. Nowadays a lot of typical network diagrams of technological and organizational relationships were compiled according to the Czechoslovak nomenclature of buildings. Next the typical courses of different sorts of structures consisting of several buildings will be created.

4. CONSTRUCTION TECHNOLOGY PROJECTING

4.1 Methodology of elaborating construction technology projects

Basic documents in construction technology projects include files of planning cards (at the level of construction technology conceptual projects), files of technological standards (at the level of construction technology operational projects. In both types of construction technology projects network diagrams are used which are closely linked with the quoted documents and enable to elaborate bar charts, line-of-production graphs and resource allocation graphs.

Hitherto the said documents, on one hand planning cards or technological standards and on the other hand network diagrams were mostly processed subsequently, separately. Their close construction technology relationship was often disregarded and network diagrams which were elaborated without consistent technological analysis and synthesis contained a number of errors which made them useless for construction project control with all consequences thereof regarding economic, time and qualitative losses. The simultaneous elaborating of technological standards, planning cards and network diagrams used in our system /3/, /4/, precludes the processing of network diagrams without technological analysis and synthesis.

The technological standard determines the technological structure of the production process (sequence of construction processes, volume of production, labour and costs consumption, number and specialization of workers or machines etc.). The technological standard includes a bar chart which indicates the time structure of the production process; a technological diagram showing the spatial structure of the process is usually added. It includes the quality assurance checklist which consists of instructions for quality control of the resulting product at every significant construction process.

According to the values of the duration of the processes and the minimum working space necessary it is possible to determine (with regard to the directions of the course of processes) the critical approximation of the processes and to link such processes immediately in optimum way.

Documents mentioned above do not depict floats in construction processes.
A network diagram which will follow up on elaborated technological standards must be therefore worked out.

4.2 Automated elaborating of basic documents

The method for automated elaborating of basic documents for preparation of structures is designed for simultaneous processing of planning cards, technological standards and network diagrams. The output includes a single bar chart, a comparative bar chart of the course of construction processes in the original and updated variant of the documentation according to the actual course of processes on site, line-of-production graph and resource allocation graphs. The BKN (Baukastennetzplanung) method is used for network diagram computation. This method introduces 4 types of relationships between the processes (finish-start, start-start, critical approach and finish-finish /3/) which represent the condition of minimum time gap ε. These 4 types were complemented with construction technology relationship, type 5, for automated calculation of the optimum approach of two processes. The network analysis is possible to do on the deterministic or stochastic basis. The proposed method enables a very simple updating of all documents according to the date of updating and percentage of completion of construction processes at this term. If there is a delay at the deadline of completion the structure the computer finds processes where more resources are necessary to shorten them to keep the deadline.

5. CONCLUSIONS - PRACTICAL USE

The method of automatic creation of basic documents of construction technology projects is in use for construction process control on many building sites, e. g. Czech National Council in Prague, Trade Unions Hotel in Giant Mountains etc. Due to the optimization of the network diagram from the point of view of the best utilization of the working space on site the total time of completion was decreased for 5 - 7 %, thus the total costs were decreased too, while the resulting quality thank to the checklist on technological standards was higher than on other building sites. The method has been recently linked with the microcomputer system of operational filing and site monitoring that brings automatically the input data for updating time schedules and other documents. It is used for dispatcher´s building production control and invoices calculation.

The system of contractor´s preparation of building production has been developed in our research establishment with cooperation with building firms of the Structural Engineering Trust Prague. After completing the system there will be a very useful implement for extending the total building production, shortening the terms of building, time, labour and energy savings and quality assurance and control leading to higher quality of Czechoslovak structures.

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Quality Monitoring by Insurance Related Control

Contrôle de la qualité exigé par les compagnies d'assurance

Versicherungsbedingte Qualitäts-Überwachung

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SUMMARY

The introduction of decennial insurance and technical control is discussed. The mechanics of control and its application to projects is examined. The relationship between control bureau, contractor and professional team is considered. The insurance cover is summarised and the factors affecting premium levels are set out. Reference is made to the Underwriter's need for technical control and its similarity to quality assurance activities applied to manufacturing processes. The standing of the control bureau vis a vis the contractor is explained and future developments are assessed.

RÉSUMÉ

Une police d'assurance décennale et un contrôle technique ont été introduits. L'article présente le système de contrôle, son application à des projets, et les relations entre le bureau de contrôle, l'entrepreneur et l'ingénieur. La couverture d'assurance ainsi que les facteurs influençant le niveau des primes sont expliqués. Référence est faite aux besoins de l'assureur d'avoir un contrôle technique semblable aux activités d'assurance de la qualité dans les processus industriels. La position du bureau de contrôle est expliquée par rapport à l'entrepreneur et les développements futurs sont esquissés.

ZUSAMMENFASSUNG

Die Einführung einer zehnjährigen Versicherungsdauer und technischer Kontrollen werden diskutiert und Kontrollmechanismen sowie deren praktische Anwendung untersucht. Die Beziehungen zwischen Kontrollbüro, Unternehmer und Planungsteam kommen zur Sprache wie auch die Versicherungsdeckung und die die Prämien beeinflussenden Faktoren. Es zeigen sich sowohl das Bedürfnis des Versicherers, technische Kontrollen durchzuführen, als auch deren Ähnlichkeiten zur Qualitätssicherung von Herstellungsprozessen. Die Stellung des Kontrollbüros dem Unternehmer gegenüber sowie die Entwicklungsmöglichkeiten werden diskutiert.

2. INTRODUCTION

In France in the 1920's the First World War was followed by a construction boom during which a number of expensive structural failures occurred. The government of the day ruled that all parties to a construction contract would be required to indemnify the building owner against structural and weatherproofing defects for 10 years and against defects in minor works for 2 years.

3. THE TECHNICAL CONTROL BUREAU

Architects, engineers and contractors then approached French insurers who agreed to underwrite the 10 year (decennial) risk provided that they received a favourable report from an independent control body. In this way the French technical control bureaux were set up.

4. RECENT DEVELOPMENTS IN UK

In England in the 1960's a number of judgements in actions following structural failures showed that parties with a "duty of care" were not adequately protected. One result has been the introduction by Government of the Housing and Building Control Act. Another has been a sharp growth of interest in decennial insurance against latent defects.

British property developers and building owners are beginning to insist on leasing agreements which require tenants to provide repairing and maintaining guarantees. It is now being realised that decennial insurance against latent defects is a convenient way for tenants to furnish the guarantees required.

In the period since 1978 there has been a gradual but steady increase in the number of decennial policies issued in Britain and since mid 1983 we have received appointments to provide a technical control service for some 50 projects. These have ranged in value of the works to be insured from £250,000 to £26,000,000.

5. THE MECHANICS OF TECHNICAL CONTROL

The Function of the Technical Control Bureau is to advise the insurer on the sufficiency of the structure to be insured.

The structural adequacy of a building is verified by a suite of computer programs written specially for this function. Compliance with British Standards and Codes of Practice is also checked. Architectural and structural detail drawings are examined as is the general practicability of the form of construction proposed.

On site the quality of material and workmanship is monitored by a team of experienced Chartered Engineers who also ensure that the works are constructed in accordance with the drawings. Detailed reports are made of each visit and at the completion of significant stages interim reports are sent to the underwriters.

These reports comment on progress, site management and housekeeping and are intended to reassure the underwriters that the works are being executed with the appropriate degree of care.

Quality monitoring of material is sometimes achieved by visits to manufacturers works and the witnessing of materials under test. During construction concrete cube test values are continually recorded and manufacturers test certificates are scrutinised.

Finally, and in time for the handover of the completed building to the owner, the control bureau will produce a report to the insurer confirming that the building represents a normal risk for decennial insurance.

Occasionally, in the early stages of a project we encounter hostility from the professional team but this usually evaporates in the common desire for the work to be executed correctly and to programme.

As the involvement of a control bureau in projects becomes more widespread it is to be hoped that reference to it will appear in contract documents. If architects and engineers know at design stage that a check on working drawings is to be carried out, closer co-operation to avoid unacceptable details should result.

6. DEFECTS

During structural design checks we have encountered significant mistakes in 10% of projects scrutinised and minor errors in 90%. These have ranged from elements which would have been severely overstressed in service to non compliance with the recommendations of the Codes of Practice on stability, weatherproofing and insulation.

Site inspections have revealed errors in the interpretation of drawings, cases of inadequate supervision leading to poor workmanship and untidy site storage with the risk of contaminating construction materials.

During our visits of inspection we take sufficient photographs to indicate the level of progress achieved and to record novel or unusual features. We also photograph defects and have found this to be the best way to have them corrected.

7. WORKMANSHIP GENERALLY

The development of computer controlled manufacturing processes results in the supply of consistently high quality building products delivered in good condition to construction sites. To incorporate these products into the building successfully requires the further ingredient of good site workmanship.

In these days of management contracts and specialist sub-contracts for all construction and installation activities advantage can be taken of the relationship between the management contractor and his sub-contractors. We have found that we can underline the importance of good site workmanship by formal meetings with the sub-contractors at which the main contractor and the professional team are also present. We then ask the sub-contractor, through the principal consultant, to talk us through the sequence of his activities and to describe the processes which he proposes to employ to ensure the quality of his workmanship.

We have also found that these meetings have an unexpected benefit in that they allow the sub-contractor to comment upon and to criticise details which may be unnecessary, or difficult to achieve. The presence of the control agency as a contractually disinterested party frequently results in a sensible workable compromise which has the agreement of all parties. This exercise is particularly useful when roofing sub-contractors are involved.

8. MAINTENANCE

The technical control function, properly applied and with the support of a good design and construction team, will result in a serviceable building being handed over at practical completion.

The continued serviceability of the structure will depend on a responsible programme of maintenance which is particularly critical in 2 areas.

8.1 External painting - which can frequently be made the subject of a leasing agreement.

8.2 Roof inspection - this requires an annual inspection of gutters, rainwater pipes and flat roof areas to ensure that all is well. A few hours spent each year can save serious damage which will result if roofs are neglected.

9. COMMUNICATION

In our experience it is important, in assessing the organisation of a project, to establish the effectiveness of the lines of communication within the professional team and within the Contractor's site management set up. We have found, on site, that our attendance at meetings ensures an immediate and effective link between ourselves and the Contractor and we have never had any trouble in getting agreement to reasonable requests for the rectification of sub-standard workmanship or materials.

The relationship between the professional team and ourselves is more complex and is influenced by the Consulting Engineer's understandable reluctance to admit to mistakes which might cost his client more money. In fairness however, it is necessary to consider two situations.

9.1 A design defect is discovered early enough to allow for it to be rectified before drawings are issued to the Contractor - in the resulting re-measurements the change is likely to go unnoticed.

9.2 We are not given drawings to check until the works are well advanced when although a defect might be acknowledged its rectification could well be an embarrassment to the Consulting Engineer. Our attitude in this situation is to try to think of ways to help in overcoming the problem as quickly and as cheaply as possible. Experience has taught us, however, that it is essential to follow up every agreement reached over the telephone with a confirmatory note.

Our conclusion is that Consultants and Contractors alike acknowledge that mistakes cannot be avoided and in general, they welcome timely criticism. Nobody likes last minute comment after the mistake has been incorporated into the works. One solution is to ensure that the technical control bureau is involved early enough to comment on working drawings before they are issued to the Contractor.

On site the preferred method is for direct confidential contact to be established between the Inspecting Engineer and the Contractor's Agent. The relationship developed between these two is vital to the quality of the works being executed.

At this early stage in the development of technical control for decennial insurance the Inspecting Engineer requires to be someone having considerable experience and tact. It is unlikely that a good Inspecting Engineer will be under 45.

If decennial insurance and technical control become the rule rather than the exception Contractors and Consultants will quickly learn what to expect from control bureaux. One day the equation may be generally accepted thus:-

Timely comment + reaction + discussion + rectification + inspection = quality

The thread which holds the equation together is communication.

10. UNDERWRITING THE RISK

Hitherto underwriters prepared to provide decennial insurance in Britain have been French based insurers with access to the statistics necessary to calculate the premiums. We understand that British insurance companies may be ready to enter the market. This would be entirely in character in an industry which started with marine risks underwriting at a coffee house in the City of London.

11. THE TYPICAL DECENNIAL INSURANCE POLICY

What follows has been summarised from insurance literature and is set out for general guidance only. As a civil engineer the author of this paper is not really qualified to discuss Insurance matters, but would be pleased to refer queries to the Underwriter.

12. THE COVER

The basic Policy covers physical damage to the premises caused by an inherent defect in the design, materials or construction of the structure. The Policy also pays for correcting the original defect. If there is no physical damage to the premises but nevertheless an inherent defect in the structure which threatens its stability and strength to the extent that remedial work is essential to prevent total or partial collapse during the period of insurance, the policy will cover the cost of this work.

Also insured is damage to the premises caused by subsidence, heave or slip of the land on which the building stands, provided that it causes damage to the structure. The policy covers this automatically; subsidence damage is not restricted to that arising from an inherent defect in the structure. Thus subsidence due to extraneous causes, such as adjacent building work, would be covered.

The basic policy may be extended to cover:-

12.1 Loss of rent, (usually subject to a one month excess and two year's rent).

12.2 It if becomes necessary to remove stock, machinery, plant, fittings or furniture whilst repair work is carried out following insured damage, substantial costs would be incurred.

These costs (including dismantling and re-erection at the insured premises) can be insured as a separate item. Provided the sum insured is adequate, cover will include temporary storage of goods removed.

12.3 When insured damage occurs it may be necessary to arrange for removal of debris from and dismantling or demolition or temporary shoring-up of the damaged part or even the entire building.

The cost of this work can be insured as a separate item.

12.4 Unless it results in damage to the Structure, faulty or inadequate weatherproofing is excluded from the policy.

However, the policy may be extended to include damage to the Premises caused by failure of the waterproofing envelope.

In addition, the cost of replacing defective waterproofing elements may be covered. This is subject to an allowance for depreciation but the additional impact of inflation can be offset by the policy indexation selected for the standard cover.

The waterproofing extension is subject to a 12 month deferment of cover from the date of Practical Completion. A further inspection of the waterproofing elements is carried out at that stage before the cover is finally confirmed.

The Insured bears 10% coinsurance of each and every claim under the extension, subject to a minimum contribution equivalent to the main policy excess operative at the time of the claim.

A separate sum insured is required for the extension.

The waterproofing cover has to be asked for at the outset, not during or at the end of the construction work, as additional Technical Control is required, and is available only as an extension to the basic policy cover.

The purpose of '10 Year Defects Guarantee Insurance' is to cover major damage, whether to structural or non-structural parts, which is why damage must be caused by a structural defect (apart from subsidence cover) and why the policy always carries an excess to eliminate minor problems.

In addition to loss of rent, it is very likely that vacation of all or even parts of the premises will incur further financial losses as a result of business interruption and these can be substantial. Annually renewable cover to run in parallel with the 10 Year Defects Insurance, for the occupier(s) can usually be arranged.

13. PROFESSIONAL INDEMNITY COVER

Decennial Insurance is not a form of replacement for Professional Indemnity insurance. Even on a Policy with subrogation rights waived the "professionals" are not absolved from potential liability.

14. EXCESS

The policy always carries an excess to eliminate minor problems which is normally a minimum of £5000. It is possible to increase this to any level and gain a reduction in the premium. The amount of excess is indexed in line with the inflationary allowance of the sum insured.

15. INDEXATION

Inflation over the years always tends to keep costs rising and this is particularly true of the construction industry. Because this is a '10 Year Policy', it is very important to make allowance for future costs. The policy is usually Indexed as a compound rate applied annually from the outset.

16. SUM INSURED

Either a 'Full Value' or a 'First Loss' sum insured may be chosen; a first loss sum insured may be indexed as well as full value. As the normal basis of claims settlement is full reinstatement a full value sum insured should represent the total estimated cost of re-building the premises, including adequate provision for related professional fees (e.g. architect's, engineer's, legal, etc.).

If a First Loss Sum Insured is chosen the insured is of course responsible for the residue.

As with most property damage insurances the 10 Year defects Policy is 'subject to average' which reduces the amount of a claim in proportion to any amount of under insurance.

Indexation should avoid the problem of under insurance. Furthermore, it is usually possible to top-up the sum insured during the period of insurance, if inflation rises faster than expected, subject to an appropriate additional premium.

An alternative is to arrange cover on a 'Deferred First Loss Sum Insured'. This is a combination of indexed full value and first loss sums insured, which allows for inflation overtaking the selected indexation level during the period of insurance. The normal indexed full value sum insured applies to the point at which inflation overtakes the Year 10 projected re-building cost. Once this occurs, the Year 10 sum insured becomes a fixed first loss sum insured for the remainder of the period of insurance, the full value or 'declared re-building cost' as it then becomes, continues to be indexed at the percentage originally selected. This additional protection against the application of average incurs a reasonable additional premium.

17. THE INSURED

This policy is assignable, which is a very important feature.

Frequently developers will not be using the premises themselves and the property will either be sold or let on completion.

Whoever effects the policy, whether for his own benefit or on behalf of someone else, is named in the policy and referred to as the 'Policyholder' until practical completion at earliest when cover commences in the name of the 'Insured'.

18. INNOVATIVE DESIGN, MATERIALS OR CONSTRUCTION

Underwriters need to consider specially any innovative materials, design or method of construction which is untried, untested or unquantifiable.

19. THE NEED FOR RISK ASSESSMENT (TECHNICAL CONTROL)

Underwriters have to be satisfied that the structure is designed and constructed to reasonable standards and is adequate for the proposed usage of the premises.

The purpose of risk assessment is to ensure that the basic risks covered by the policy - inherent structural defects causing damage or threat of collapse and subsidence are reduced to economically acceptable levels.

It is this reduction or control of the risk which is the primary function of Risk Assessment, in many ways similar to the surveys and inspections carried out in connection with other types of insurance (e.g. fire, theft, engineering).

However, most other insurances are on a annual renewable basis which enables regular resurveys to be carried out and terms revised, or even the policy cancelled, if necessary. This '10 Year defects Insurance' is a '<u>once and for all</u>' non-cancellable commitment once cover has started.

The policy definition of the insured also incudes 'any person who acquires the Freehold or Leasehold Interest in the premises during the period of insurance', so that any subsequent owner or tenant, as the case may be, can be insured.

20. PREMIUM PAYMENT

There is a Single Fixed Premium for the entire 10 Year Period of Insurance. Additional premiums can be incurred for any amendments to the original basis of the Policy.

The premium is calculated at the outset by application of a rate per cent to the full value sum insured - or, in the case of first loss insurance, the Declared Rebuilding Cost. The same premium rate is normally applied also to the sums insured for removal costs, debris removal costs and fees. Loss of rent and water proofing covers are subject to different rating factors.

21. PREMIUM RATING FACTORS

A number of technical factors affect the level of premium rate including :-

a) The type of building and its intended use b) Project location
c) Design and type of construction d) Foundations and soil conditions
e) Amounts of excess and indexation f) First loss or full value cover

The premium cost including control fees will normally fall within the range 1.00% to 2.00% for those contracts where the policy is effected at the start of construction. There is a minimum premium of £5000 including fees.

22. TECHNICAL CONTROL AND QUALITY ASSURANCE

The technical control process requires that a series of reports be sent to the Underwriter to inform him that significant stages of the works have been satisfactorily designed and constructed. These are :-

Report No. 1 - Initial Report (which gives a general description of the work, lists the parties to the contract and enables the insurer to indicate the level of premium which will be charged upon receipt of a favourable final control report).

Report No. 2 - Ground Conditions, Foundations and Substructure	) issued at the
Report No. 3 - Main structure	) satisfactory
Report No. 4 - Cladding and Building Envelope	) completion of
Report No. 5 - Roof Support and Waterproofing	) each phase

Report No. 6 - Final report on Practical Completion and Finishes

Report No. 7 - 12 Month Post Construction Report (issued only if insurance cover has been requested for the roof waterproofing).

The issuing of these reports is a stage by stage endorsement of the quality of the works constructed. Technical control as a means of ensuring quality is therefore just as valid as the methods adopted by QA Inspectors during the various stages of manufacture of factory products. However the client (customer) of a construction project where insurance related control is applied has the further protection offered by the insurance policy.

23. THE CONTRACTOR

After some initial misgiving the Contractor usually comes to accept technical control as no worse than the intervention of Local Authority inspectors. The control bureau has no contractual standing and hence cannot issue instructions. it is usually enough to draw the contractor's attention, discreetly, to an item of poor workmanship or incorrect interpretation of a drawing to have the desired result.

24. FUTURE DEVELOPMENTS

The Housing and Building Control Act allows Local Authorities to arrange for certain categories of work to be privately certified as complying with the Building Regulations. The Act requires that such privately certified works shall be insured against latent defect for a period of 10 years, and that the person certifying the works shall be insured against negligence for 15 years.

Evidence of a willingness to underwrite a 15 year risk has not yet been found and Government may have to reduce this period before the market will respond.

It is felt however that after further development Britain will have a well established market for long-term insurance against latent defect. As a step towards effective quality assurance in the construction industry this must be welcomed.

Project Organization and Contract Management

Organisation du projet et évolution du contrat

Projektorganisation und Vertragsabwicklung

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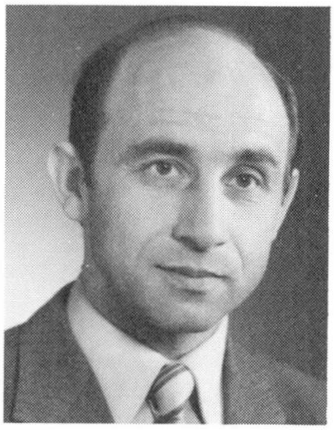

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SUMMARY

Today, the conceptual set-up of project organization before tendering and contracting and its development and review during contract fulfilment is much more than a primitive art. The project organization can be designed and tailored to the actual objectives, phase, services, works, contract partners, and environmental conditions. Highly qualified organizational work is appropriate for the important tasks of quality assurance and to using human talents and effort effectively.

RÉSUMÉ

La conception de l'organisation du projet avant l'appel d'offres et l'adoption du contrat ainsi que les projets de détail et la modification en cours d'étude et d'exécution sont devenues aujourd'hui plus qu'un art primitif. L'organisation du projet peut être prévue et organisée en tenant compte des objectifs finaux, des phases du projet, des différentes prestations, des partenaires du contrat et des conditions de l'environnement. Un travail spécialisé et de haute qualité est requis pour obtenir une qualité supérieure et un emploi efficace et satisfaisant des talents de tous les partis concernés par le projet.

ZUSAMMENFASSUNG

Das Konzipieren der Projektorganisation vor Ausschreibung und Vertragsabschluss und das Detaillieren und etappenweise Modifizieren derselben während der Vertragsabwicklung ist heute bedeutend mehr als eine naive Kunst. Die Projektorganisation kann auf die jeweiligen Projektziele und -phase, die allgemeinen und speziellen Leistungen und Projektbeteiligten und die Wechselwirkungen mit der Umwelt ausgerichtet werden. Eine hochqualifizierte organisatorische Arbeit ist dem allgemeinen Bestreben nach höherer Qualität und dem wirksamen und befriedigenden Einsatz der Talente der Projektbeteiligten angemessen.

1. INTRODUCTION

A **project** is an undertaking consuming limited time and resources. In systematic, **multi-level** construction project management, there are many kinds of projects, for example:
- the entire construction project from the owner's initial ideas to a constructed facility in operation
- a feasibility study
- the design of an electrical subsystem
- the construction of access roads
- the delivery of a set of large turbines
- the set-up of a plant operating organization.

A project tunes and gears the effort of the respective team to a common goal.

The **project organization** (1) is the group engaged in planning and realizing the project. This organization should be tailored to the requirements of the specific project and its actual phase. Organizational methodology creates better prerequisites for the work of the persons and organizations involved, improves the overall quality of the end result, and supports the actual organizational work. In addition to methodology, adequate experience, theoretical knowledge, and know-how and skill in the widest sense, and the coincidence of personal and project objectives are essential for the successful organization of construction projects.

The **contract** is a legally enforceable agreement between two or more parties. When undertaking a project, an organization may use

- Resources of its own.
  Then the persons involved in the project work for it on the basis of their **employment** contract and internal organizational decisions.

- Outside resources.
  Then other organizations provide capital, goods or services on the basis of **lending**, **work**, or **consultancy** contracts.

In addition, the project organization may let facilities or sell goods within the range of the project mission which leads to **other** types of contract.

When discussing the influence of contract management on project **quality assurance**, emphasis is normally on writing and checking specifications. In this paper, attention is drawn to the set-up and review of the organizational conditions for the project performance. Organizational work should be done before contracting, and maintained during contract fulfilment. This means to recognize the suitable work tasks and functions for each project phase, to allocate them to a tailor-made project organization that is performing them optimally, to design and maintain adequate information and decision procedures, and to ascertain the engagements by contracts.

Actual **problems** arise from

- Under/overestimating the legal aspects
  (missing knowledge of construction law and/or the opinion that contract management should be the lawyer's business)

- Hasty/lengthy contract establishment
  (high time pressure leading to unclear or contradicting clauses / innefficient, time consuming negotiations)

- Contradictions between contract and organizationally favorable arrangements
  (organizational work not done at all or not done before establishing the contract).

Similar problems can occur in the technical and economic fields.

2. CONSTRUCTED FACILITIES

The end result of a construction effort is an **operated physical system** (3) in a defined environment, i.e. a dynamic and open system. A system should have a definable, e.g. goal-oriented, behaviour. If this is not the case, it is a deficiency of the system's design, skills or quality or a deficiency of the analyser's knowledge. The constructed facility is to serve specific purposes, i.e. future functions in its environment. The overall task to erect a physical structure with an established performance target must be a part of the owner's goal concept. From conception to completion, its scope and objectives should be clearly defined again and again.

The impact of the environment must be identified, analysed and taken into consideration at all times. The **framework conditions** are classified in their logical order (2): Technological, economic, legal, and socio-psychological. Not everything that is technically feasible will also be paid. Not everything that is technically feasible and payable will also be authorized. And not all the technically feasible, authorizable projects that we can afford are really desirable. The framework conditions affect the goal structure of the construction project. Unlike boundary conditions, they may change in the course of time or may first have to be established during the project time.

Technical, economic, social, cultural and mathematical actions all include an important **human aspect** as opposed to states and transformations taking place without the assistance of a human being. Projects can be realized, if they create a sufficient amount of motivation to reach a positive outcome of the respective decision. Engineers should not rely on promoting unwanted projects, and they should be able and willing to take over the responsability on the overall effects of their projects.

3. PROJECT ORGANIZATIONS

Organization theory says that a detailed analysis of the complex overall task should be the starting-point for the design of the organization's structure. The characteristic features of a **task** are:

- the substance of the task, defined in terms of quantity and quality, executed on a certain subject or object with the necessary aids

- the allocation of the parts of the task to the individual performers, building up the structure of the organization

- the definition of the procedures to be observed and run when performing the task.

The persons as doers are the decisive elements in construction project organizations. Goal-oriented work requires that the tasks are derived from situations and objectives.

The situations, the objectives and the tasks and performance are key elements of **project management** and mark the starting-point of every organizational structure. Project management coordinates the work tasks by designing and reviewing the project organization, by checking the technical interfaces, by time scheduling, and by benefit and cost management.

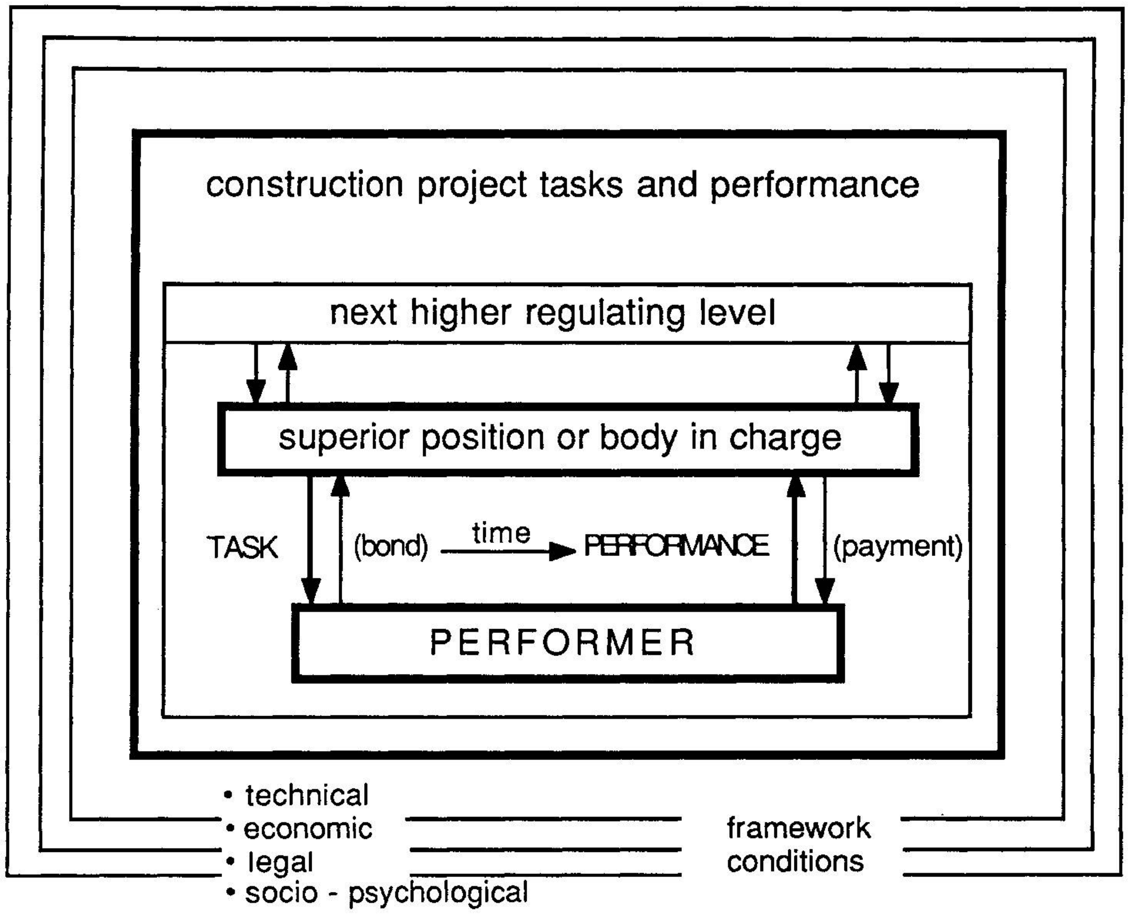

Figure 1: Construction project tasks and performance

Tasks and performance are managed on different levels. Using the same general methodology makes the coordination of the system easier. Tasks can be split into two functions (Figure 1): the function of the superior position or body in charge and the function of the performer. The superior position takes over a **regulating function** in line with the cybernetic systems theory, whereas the performer becomes the so-called regulated system that actually deals with the problem or work task. A controlling decision of the superior position in charge is frequently the result of a complex opinion-collecting and intention-forming procedure. The processing capacities of both the regulator and the task performer must be sufficient, if not, the next higher level has to act.

The **objectives** of a person as a goal-oriented performer in a construction project organization can be allocated to three different ranges:

- individual objectives (personal objectives)
- the parent organization's objectives (employer's or client's objectives)
- the objectives of the project team (project organization).

The objectives of a project organization can be achieved with less conflicts, if the personal objectives of key persons engaged in the project, and the objectives of the parent organizations are going in the same direction as the project objectives.

4. CONTRACTS

The contracts (5) are the legal form of mutual obligations that the parties agree upon. Usually, the owner gets services and goods from the performer and the performer gets an amount of money from the owner. The most frequent **contracts,** in **construction projects** (Figure 2), can be characterized by:

- the services or goods transferred:
  services, works, goods (purchase), employment, money (lending), facilities (letting, leasing)

- the price type:
  lump sum, unit price (per unit of quantity), cost plus (per resource unit).

Further subdivision (e.g. according to the types of services: project management, engineering, architectural, geotechnical) and combination (e.g. turn-key) are quite common. Other kinds of differences are the type of contract award (qualification procedure, bidding, negotiation), the type of activity referred to (operation of constructed facility, new construction, maintenance and replacement), and the location of the facility (culture, applicable law, market, technical standards).

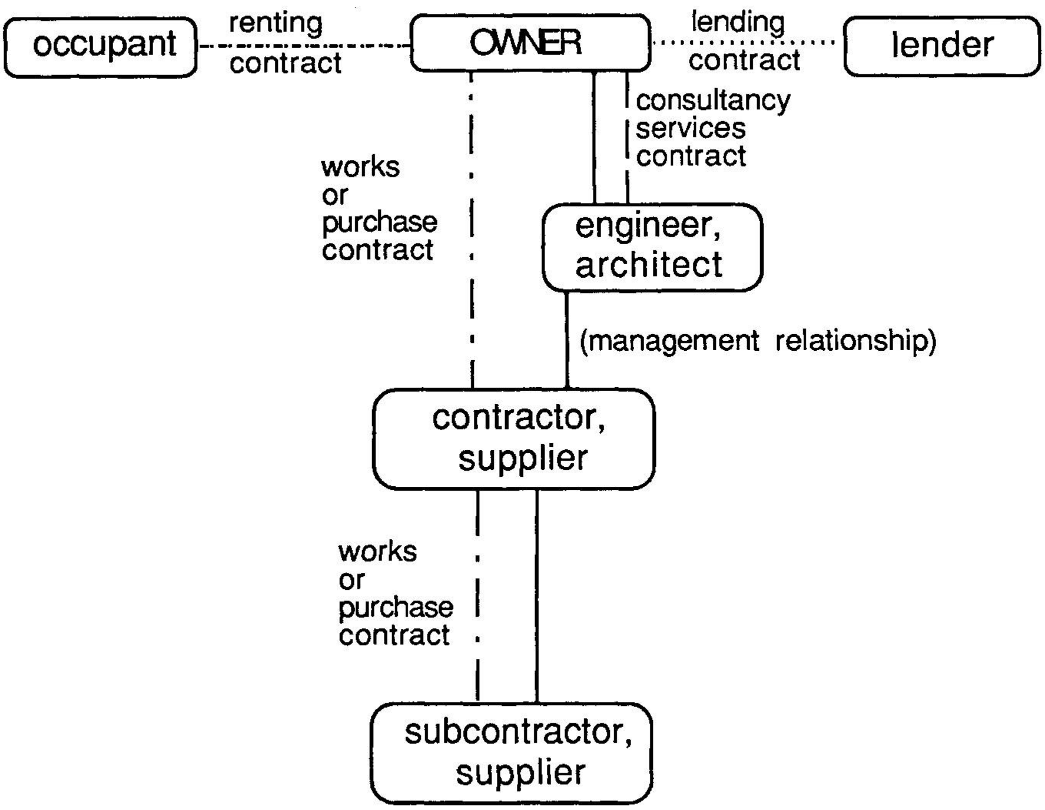

Figure 2: Frequent contracts in construction projects

The complete **contract agreement** usually consists of the following documents: conditions (general, special, supplementary), drawings and specifications, addenda, an agreement form, and modifications (amendments, change orders, interpretations). In a more logical order, these documents refer to the following subjects:

- the inputs from the owner (task description)
- the output of the performer (specifications, results to be achieved)
- the prices for the performer's (and owner's) contributions
- the responsibilities and the procedures (liability, resources provided, time schedule, payment conditions, structure of the project organization, change procedures, etc.)

and to the following chronological sequence:

- general (for any project)
- special (for a specialty area of any project)
- supplementary (unique to a given project)
- additional (during bidding or negotiation)
- agreement form (for signing, very important and particular clauses)
- modifications (during contract fulfilment).

A more similar structure of contracting in all countries could contribute to improving the international exchange of experience and research results.

5. METHODOLOGY FOR ORGANIZATIONAL WORK

The appropriate design of the project organization for each phase is a most important factor for the success of a construction project (1). The idea of **extending the quality** of the existing and new constructed facilities to
- a favorable life-cycle performance and operation
- beneficial interaction with the environment
- and new aspects of welfare

has got a growing acceptance. Expert knowledge in a large number of specialty areas can be used to enhance the benefit of the socio-technical systems. The owner's organization, the project scope, the external experts and pressure groups, the operations planning and management, and quick computer information became more important than in the past. Project management is facing new challenges to its organizational skills (4).

A systematic analysis of **eight selected projects** in Switzerland including industrial buildings, traffic facilities and heavy construction in urban areas has shown the relevance of organizing from the start to the end of construction projects (2). A similar study was undertaken in the United States (6). Thinking in terms of systems and alternatives is not so common as it should be. A major problem arose when project management did not govern well enough the project as a whole. In successful projects, the boundaries were appropriately defined, and numerous framework conditions were be taken into account. The realization of targets was under full control and the project organization was able to react and had the foresight to act. Due consideration was taken of all persons affected by the construction project and their probable interest. The set-up of the project organization was straight-forward. Sometimes, persons in key positions react quite helplessly and emotionally towards socio-psychological influences.

The methodology proposed consists of three parts:

- A method for **analysing** construction project organizations that is a systematic list for checking project definitions, project organization structures, specifications for services, objectives and procedures, and management tools.

- A procedure for **developing** and **modifying** project organizations that is an application of the general problem solving process.

- A set of **rules** for the design and the management of project organizations that are recommendations from the real projects and from organization theory.

Emphasis is on systematically dealing with the project environment and the goal structure of all persons involved or affected, as well as on a procedural model for developing and modifying the project organization. A first test has shown that expert systems are an effective tool for organization analysis and qualification procedures.

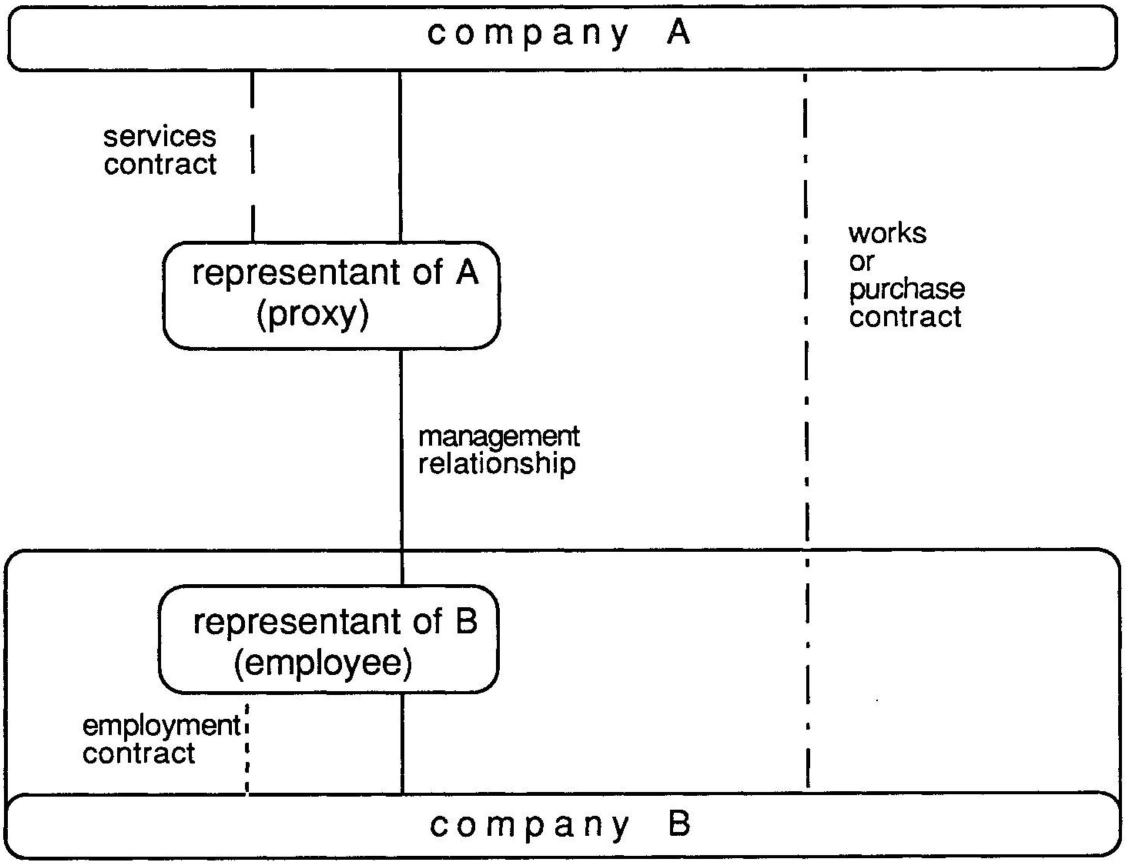

Figure 3: Contract and management relationship

Some **organizational deficiencies** are reducing the quality of today's project performance. The tasks in the "non-construction" areas such as the tasks of the owner, the process and industrial engineers, the persons representing the project environment, the operators of the constructed facility, and sometimes even the project management tasks are not sufficiently specified. In addition, the skills of managing projects professionally and of coping with multidisziplinary problems (such as the organizational and legal implications of representation, Figure 3) could be improved in many permanent organizations. Systematic project management in the owner, agency, consultant, contractor, and user organizations is not only an advantage for these companies but also a major achievement towards a well orchestrated total project management.

6. PREPARATIONS FOR CONTRACTS

If each contract document had to be created from scratch, lots of problems would arise. It is favorable to study the **standard** structure and substance of contracts on the basis of general experience, systematic analysis and development, and a fair balance of interests apart from the concentrated work on a specific contract. The standard documents shall provide a professional **starting-basis** for the specific work on an individual project. In Switzerland, both the general conditions for construction work (7) and the standard agreement for engineering and architectural services (8) were improved considerably in the past ten years.

The conditions for engineering and architectural **services** deal with

- the input from the owner, a task description (cahier de charge, Pflichtenheft, project guideline) including the owner's and project objectives for each phase and the existing information on the project.

- the definition of the professional services (these services are the most important part of the agreement)

- the methods and figures for calculating the fee (which is the necessary economic basis and incentive for the work of the engineer and architect)

- the general legal contract conditions concerning liability, general duties, copyright, change and closing down procedures etc. (they are concentrated in one part rather than distributed all over the contract).

The general conditions for construction **works** include the general business conditions, the reimbursement to the contractor, the change orders, the responsibility, and the commissioning. Responsibilities and duties of the contractor also appear in many technical and safety standards. The technical specifications become more standardized as well by the growing application of standard specifications in Switzerland. Computer processing and electronic data transmission will accelerate this trend. Finally, the standardization of drawings is advancing.

Concerning the **project organization**, the following rules should be observed:

- The conceptual part of the organizational work should be done **before** the bidding documents are established and the contract is signed. Particularly, the definition and delimitation of tasks and responsibilities, the determination of interdependencies and procedures, the careful analysis of the permanent organizations and persons involved.

- Professional organizational work should be done again and again **during** the performance of services and works. Particularly, each new phase of the project should be initiated properly with a final report about the previous phase, a review of the organization and a new start.

- The project organization should be reduced and dissolved by doing the **last** piece of organizational work carefully as well. Particularly, an appropriate documentation, instruction of the organization operating the facility and clear and written decisions on the fulfilment of the contract by all parties are appropriate.

With the last revision of the general conditions for engineering and architectural services of the Swiss Association of Engineers and Architects, the duty of proposing the project organization became a basic engineering and architectural service to the owner, if they offer complete direction, design and supervision services, as opposed to specialty services.

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