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THE BUILDING PROCESS IN CANADA

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PROCÉDÉS DE CONSTRUCTION AU CANADA

SOMMAIRE

L'auteur fait une brève récapitulation des méthodes actuelles de construction des bâtiments au Canada et décrit celles qui sont les plus employées par cette industrie, ainsi que les canaux de communication correspondants. Les rôles du propriétaire, de l'architecte, de l'ingénieur-conseil, de l'entrepreneur, des sous-traitants, des ouvriers et des fabricants sont décrits brièvement tout comme le sont leurs relations de l'un à l'autre et leurs relations avec d'autres organismes s'occupant de construction directement ou indirectement. L'auteur présente quelques remarques pertinentes sur les besoins de renseignements et de canaux de communication ainsi que sur les nouveautés en ce domaine.

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The building process in Canada

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The pattern for the initiation and procedure of work may vary for certain segments of the building industry in Canada. For most non-residential building construction, the usual method of initiating work is for the owner to have drawings and specifications prepared by an architect and engineering consultants and to contract with a general contractor who, in turn, sublets parts of the work to special trade contractors. In some instances, the general contractor may act as owner and builder, using his own designers or he may engage an independent firm of architects or engineers to carry out the design phase. These two last-mentioned arrangements are the ones most commonly used in the housing field. Houses and small apartment buildings are built by merchant builders; large structures are usually designed for the owner-builder by a separate architect and engineering firm. Other arrangements are sometimes used but in all cases the decision as to procedure is made by the owner.

Contracts

Contracts for larger buildings are usually awarded on the basis of a call to tender. This is done either by an open invitation to bid published in newspapers or in trade journals or by direct invitation to selected contractors. Where competitive tenders are called for and are invited, the contract is usually awarded to the firm that has submitted the lowest bid.

The mots common type of contract is the fixed contract, although cost plus an established fee is also used. Standard forms have been developed for both types approved by associations representing the architectural, engineering and construction interests. Standard forms for contracts between owner, architect and consulting engineer, and between general contractor and subcontractor have also been developed.

The procedures and regulations governing the awarding of contracts are not standardized, corporations and individuals are free to use whatever method is best suited to their requirements. Government bodies spending public funds are, however, subject to some restrictions, the regulation being most exacting in the case of Federal Government contracts. It is usual practice that the contractor provide a bid bond or certified cheque as a tender deposit. The deposit of the successful contractor is held by the owner until the completion of the contract. A holdback of 1o to 15 per cent is usually made on the monthly payments, which are based on progress estimates made by the architect. These monies are held until after the completion date plus a period of time set by provincial statutes for expiry of lien rights, usually thirty days.

Certain abuses of the tendering practice have given rise to the use of the bid depository system for protection of subcontractors who are submitting bids to a general contractor. The bid depository prevents a general contractor from first obtaining a contract and then bartering with the subcontractor in an attempt to obtain a lower price. This system is used in an endeavour to prevent a subcontractor from determining a competitor's price and then submitting a lower bid. Some owners attempt to obtain the same result by requiring the general contractor to list his subcontractors and prices in his original tender and by requiring him to use only those subcontractors approved by the owner or architect. There is some agitation by building material suppliers to initiate bid depository arrangements for their submissions to subcontractors.

The competitive bidding process is of prime importance in teh functioning of the production phase of the industry in Canada and influences the activities and organization of all segments of the industry. It may act to restrict the flow of information where some immediate competitive advantage is to be gained, but in the long run promotes the desire for information and interest in innovation through competition.

The information flow processes are perhaps best dealt with by a consideration of the various groups making up the industry or those associated with it.

The Design Professions

The architect is usually the prime consultant to the owner but is associated with engineering specialists or other consultants where necessary or desirable. In the past, and in small building

jobs, the architect humself undertook the total design, or obtained engineering assistance indirectly through teh suppliers of structural steel and heating, plumbing or electrical equipment. The increasing complexity of modern building and extension of the work of engineering comsultants has led to the development of firms offering both architectural and engineering service or to the formation of consortiums of design specialists. Such arrangements often afford a greater oportunity for communication between the various specialista in the early design stages, and can develop a better understanding and appreciation of each specialty by the other.

The normal process of design first involves the preparation of a project brief that outlines the requirements of the owner. Preliminary sketch plans are then prepared by the architect to establish siting, space relationships, and appearance. During this phase, the specialty engineering consultants are usually not involved except to provide general advice regarding rough sizes and arrangements of structural components or space requirements for mechanical equipment. Approximate estimates of the total building cost are made, based on the architect's experience, the advice of his consultants and, in some cases, with the services of an independent estimator. The architect and his staff then proceed with the preparation of architectural working drawings and specifications; the structural consultant and the mechanical and electrical consultants are involved at later stages.

Working drawings and specifications are usually made by junior architects, specification writers, and draftsmen under the supervision of a project architect. The development of details, selection of materials, and preparation of specifications relyheavily om the experience of the members of the group, the accessibility of information on available products, and the availability of standards of specifications. Frequently technical representatives of manufacturers are used informally to advise on availability or method of constructing some particular feature. Emphasis is on the adequacy and future performance of the completed building rather than on the method of producing the building.

Working drawings and specifications must, in the first instance, satisfy the minimum standards for public health and safety established by provincial or municipal authorities concerned, and those functional standards established by the pertinent non-building authorities that have a financial or social responsibility with the owner. Standards for public health, structural sufficiency and fire safety are basically the responsibility of the province, delegated in whole or in part to the municipality or urban government. National uniformity of such standards is being approached through voluntary adoption of a National Building Code, a document prepared under the auspices of the National Research Council.

Plans and specifications are usually prepared to allow competitive bids as to materials and components. When the requirements on performance cannot be simply or accurately described, specific products may be mentioned, with or without the inclusion of "performance" standards, and the national standards writing bodies are looked to by the industry as a means to this end.

The architect and engineering consultants will usually be engaged by the owner to carry out regular inspection of the work once the contract is let, to ensure that it is carried out according to plans and specifications. The inspector or clerk-of-works acts as the link between contractor, designer, and owner, and arranges for the approval of detail drawings, change orders, and progress estimates. The architect or engineer is responsible for supplying any additional drawings required for the execution of the work, and must ensure that all drawings and additional instructions are consistent with the contract documents. In case of dispute, the contractor must act in accordance with the architect's decision but may submit claims for additional costs to arbitration, if necessary.

Detailed cost information on the work as it progresses is not readily available to the architect since the organization and cost accounting are handled by the contractor. His only access to such information is through the break-down of sub-trade bids, or from unit costs supplied through the terms of the contract.

Most architectural and engineering offices have some individuals or a group concerned with the filing of technical information, trade literature and standard specifications for use in the development of plans and specifications. The classification and coding of this information is not at present based on any one system, and any system used will usually be modified to the particular perference of the individual in charge. Interest in the development of appropriate systems is growing, and several trade and government agencies are working toward this objective.

The General Contractor

The general contractor is responsible for the detailed planning, scheduling, and progress and cost control involved in the building process. His experience and ability in these aspects largely determine his competitive advantage although he

relies heavily on the ability of his subcontractors to carry out their portion of the work according to plan. The general contractor will often have his own forces for concrete, masonry, carpentry and unskilled labour, but will sublet most of the remainder to specialist subcontractors. His primary function is thus to organize and coordinate the work of his subcontractors with his own work on the job site.

The permanent emplpyees of the contractor include an office staff of clerks, bookkeeper and estimator, and an outside staff of superintendents and foremen. He will employ skilled and unskilled labour from time to time and usually retains some of these personel on a permanent basis, depending on the volume of work he has at hand or anticipates.

In preparing his initial bid, the general contractor need prepare detailed estimates of only a small portion of the total work, as his subcontractors will be bidding to him for the remainder. He is thus most concerned with the coordination of the work and scheduling of work and materials and may thus use reasons other than price in the selection of his subcontractors. Once the general contract has been awarded, the key figure in the process is the general contractor's superintendent. Although not directly involved in the detailed planning and costing of the subtrades labour, the superintendent must have a knowledge of all the specialties and the sequence of their work, in so far as they affect the progress of other trades. He, like the subcontractor's superintendent, is also responsible for the feedback of progress and cost information for project control and future use in planning and estimating.

The proposed construction schedule is usually prepared in graphical bar chart form showing the several subdivisions of the work in time scale. It is used as a basis for periodically coordinating the interdependent operation through job conferences of the heads of the various subdivisions. Depending on the complexity of the project, such conferences may be held on a daily basis for foremen and subcontractor superintendents, and at more infrequent intervals between the general superintendent, major subcontractors and architect and engineers. An increasing number of major contractors are utilizing the techniques of network analysis exemplified by the Critical Path Method (CPM) or Project Evaluation and Review Technique (PERT). Although the majority of projects involve manual application of these techniques, interest in and application of computerized systems for very large jobs is increasing.

When the contractor's bid is accepted, a cost account code is assigned to every item on the bid and the actual costs are segregated accordingly by the cost keeper as the work progresses. The coding system used varies between organizations; usually an arbitrary alpha-numerical system is used which is designed to obtain unit costs for each particular operation. Each foreman is responsible for completing a daily card on which he lists the men working for him and their activities. These cards are used to make up the payroll and to enter labour costs associated with a particular section of the construction. Invoices for materials as they are received are tabulated with labour data to provide a daily or weekly summary of labour and material cost from which unit costas may be obtained.

The resultant actual costs are studied by the contractor and compared with bids so that immediate improvements may be introduced if necessary by superintendents and foremen to attain better efficiency, by estimators to improve future bids and by the manager to evaluate performance and trends compared with other jobs. Usually a complete report is prepared when the contract is completed, responsibility determined, remedial action taken and estimationg procedures updated and improved. Some large contracting firms use office machines for cost accounting and payroll accounting.

Information on labour costs and, to sone extent, material costs experienced in the building process are normally recorded only by the responsible contractor (general or specialist) and are available only to him. The architedt or owner's representative is responsible for checking the progress estimates for payment byt usually he cannot obtain detailed labour-material breakdowns. Labour charges are based on hourly rates of pay in almost all cases; piece-work rates apply o n l y to some operations of wood-frame house construction where non-union labour is involved. The general contractor has little detailed knowledge of the labour and material cost or unit prices for many of the construction operations, because he accepts fixed total price bids from his many subcontractors.

S u b c o n t r a c t o r s

The increasing complexity of modern building has led to a contimued growth in the number of specialist trade contractors. The ten major trades recognized in years past: bricklaying; carpentry; concreting; electrical work; lathing and plastering; painting and decorating; plumbing; heating and air conditioning; roofing and sheet metal work; tiling, marble and terrazzo, have in recent years become subdivided or augmented by many others.

Many of the specialist subtrades will not submit a bid direct to the general contractor but to a major

subcontractor. The accessibility of these sub-bids, the supervision and coordination of work and the job costing during progress of the work becomes the responsibility of the major subcontractor. A pertinent example of this pyramidal substructure is the mechanical subcontractor who is responsible for plumbing, steam fitting, refrigeration, sheet metal work, control system installation and other specialist sub-subtrades.

The material supplier - subcontractor has also developed in recent years due to the development, by manufacturers, of materials requiring special application techniques. Two examples of this are the curtain wall contractor, and the partition and suspended ceiling system contractor.

Labour and Labour Skills

The ultimate responsiblity for the production of building lies with the construction workers who have developed largely on the basis of traditional trades. The ratio of skilled to unskilled workers is approximately three to one in building construction; the ratio is slightly higher for inside work. The majority of workers are covered by labour agreements and are predominantly members of international unions, except in house construction which is almost completely non-union.

Craft traditions are an important factor in union organization. The unions aid in the maintenance of craft standards through apprenticeship training programs, in co-operation with provincial government labour departments. Skilled workers in the various crafts are the chief source for foremen and superintendents, estimators and other non-professional managerial positions in the contractor's organization. Rapid advances in technology and methods for scheduling and costing are demanding more from the skilled tradesmen than merely familarity and skill with established methods of construction, particulary as he advances into management. Consequently, accelerated training of craftsmen, through technical institutes and special courses in mangement and technology are being promoted by both government and industry.

Manufacturers and Suppliers

Building materials and components are supplied by the manufacturers to the user through a multitude of channels. Some traditionally basic materials such as brick, tile and structural steel are distributed direct to the contractor by the manufacturer. Most of the other materials and products are obtained through local distributors who, for some specialty products, may act as the installer or subcontractor. Most manufacturers, however, maintain technical sales personnel who promote and advise engineers, contractors and tradesmen in the use of their products. They may also train the distributor salesmen or offer special technical assistance when necessary. In all cases, a substantial effort is made toward the production of technical and promotional information.

The manufacturers are the primary innovators of the industry. They devote considerable energy to the development of new materials or to broadening the market for those currently in production. Althoug cost reduction is of prime concern, improved performance in relation to competitors' products is an important motivation.

Regulatory Groups

The use of new materials is conditional on their acceptance by building authorities. In Canada such authority is given to the provincial governments, and by them delegated to municipalities and urban government. In the case of housing financed under the National Housing Act, materials and components must be accepted by the Central Mortage and Housing Corporation in the first instance, but such acceptance is not mandatory for local authorities. The popular acceptance of materials by the market and by labour unions is also necessary before widespread use is obtained.

The authorities responsible for acceptance rely heavily on the assessment of materials and components by virtue of their conformity with established physical standards and to performance evaluation by standard test methods. The preparation of such standards through the Canadain Standards Association, Canadian Government Specifications Board and The American Society for Testing and Materials and others is based on industry participation.

Trade Associations

Trade Associations play a vital role in communications in the building industry, whether they concentrate on labour relations, government liaison, management, or costs and technical information. Almost all are concerned in some measure with technological progress and information dissemination and with the general improvement of their relationship with other members of the industry.

The Canadian Construction Association is the most representative, embracing all segments of the sub-contracting, building and materials supply phases. The National House Builders Association concerns itself with a more restricted area, working closely with the Central Mortgage and Housing Corporation of the

Federal Government. Specialist trade associations such as the Canadian Institute for Steel Construction, the Canadian Wood Council, the Canadian Institute for Timber Construction, National Concrete producers' Association, Structural Clay Products Association and Canadian Roofing Contractors Association are technically oriented and produce design information and application specifications.

Government Agencies

Various agencies of government participate in the production and dissemination of information of value to the building industry. In the field of research, the Mines Branch of the Department of Energy, Mines and Resources undertakes studies in the development and use of materials of natural origin. The Forest Products Laboratories of the Department of Forestry and Rural Development is concerned with the use of wood and wood products; the Prairie Farm Rehabilitation Administration is concerned with soils, foundations and concrete for engineering structures; and similarly the Ontario Hydro-Electric Power Commission undertakes studies on soils, concrete and equipment associated with its operation. The one federal agency concerned with all aspects of building research is the Division of Building Research of the National Research Council of Canada.

The Division of Building Research has three specific functions: to provide a research and technical information service to the building industry as a whole, to act as the technical research wing to CMHC, and to provide the necessary technical and secretarial services for the Associate Committee on the National Building Code. It has concentrated its efforts on the accumulation, production and dissemination of technical information, advocating, where appropriate, those techniques and procedures leading to increased efficiency in the production phase of the industry. More recently the Construction Branch of the new Department of Industry has been able to add its efforts to promoting the use of National Building Code, modular coordination, and to the development of programs to assist the construction industry in research and development.

Information Requirements in the Building Industry

The recognized need for increased production and increased productivity throughout the building industry in Canada has focused attention on several areas where improved communication of information is necessary. Many of these areas are probably under active study by special individuals or groups and have not achieved national prominence. There are, however, some studies and current programs that provide an indication of problems and developments in the Canadian scene.

Currently, much attention is being given to the need for improved methods of collecting, organizing and retrieving information on new building products, systems and equipment. The Canadian Joint Committee on Construction Materials representing contracting, designing and manufacturing interests was set up in 1960 to improve the communication between these interests. This effort has now been carried further by the Department of Industry of the federal government through a survey of the needs, requirements and feasibility of a construction information system. Concurrently, studies of possible system designs, coding and indexing, computerization and means for organizing, financing and managing such a system are being considered.

Other agencies are involved in this program and are similarly concerned with the classification and coding of technical information. The Specification Writers Association of Canada have adopted the Building Construction Index (BCI) system as a basis for filing information, and it is also being used in many architects' offices. The Division of Building Research of the National Research Council is particularly concerned with the production, retrieval and dissemination of technical information. The DBR/NRC library, a branch of the National Science Library, has been developed as the Library of Canada's construction industry. It is involved in the assessment of classification and coding systems and is providing a steadily increasing service to the industry. It does not handle product information.

The Division Building Research initiated a series of monthly Canadian Building Digests in 1960 as a means of condensing the pertinent information on a specific sebject, and interpreting it for the practitioner. These Digests have achieved considerable acceptance and success as a method of communicating technical information, particularly through their use as a basis for regular Science Seminars conducted by the Division.

The acceptance of modular coordination as a means of improving efficiency and communication in the design and construction of buildings has long been urged by the Division of Building Research. Through recent promotional efforts of the Department of Industry in the organization of seminars and workshops and through its adoption by the federal Department of Public Works for all future work, the increasing use of modular coordination is almost certain. A directory of Canadian modular building materials is being prepared by the Department of Industry. There are, however, several problems in

the communication of information in the construction operation which are not receiving the same attention.

The full utilization of modern management techniques involving detailed planning, scheduling and control is not being realized. This is due in part to the traditional structure of the industry, its craft rather than technological base, to the shortage of management personel and to the separation of design from procudtion. Efforts are being made by the industry associations in conjunction with some universities and institutes of technology toward the training and continuing education of construction personel.

The growing interest in industrialized building techniques and systems by professional organizations, industry associations and government agencies will, no doubt, lead to improved communication and greater integration within the industry. Such progress will not be without its problems and the experience of other countries, more advanced in this approach to building, will be of great benefit.

The acceptance of industrialized building techniques will be greatly facilitated by the complete adoption of uniform building regulations and by the development of standard specifications and testing methods. The National Building Code, prepared as an advisory document by an Associate Committee of NRC representing industry and government, has gained wide acceptance across Canada. Various standard writing bodies, such as CSA, CGSB and ASTM are active in developing nationally accepted standards for materials and components as well as test methods. These various standards have been compiled in a comprehensive index for use by the industry and for possible intetration into any information system that is developed.

Finally, it should be mentioned that an extensive inquiry sponsored by the industry into the organization, labour relations and legal environment of the construction industry has recently been made. The findings and conclusions of this inquiry may well have a significant bearing on the labour-management communication within the industry.

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