A STUDY OF COMPUTER UTILIZATION IN THE CANADIAN CONSTRUCTION INDUSTRY

THE DEPARTMENT OF INDUSTRY, TRADE AND COMMERCE
Ottawa, Canada

Prepared under the BEAM PROGRAM by
DEMERS, GORDON, BABY
Consulting Engineers

A STUDY OF
COMPUTER UTILIZATION
IN THE
CANADIAN CONSTRUCTION INDUSTRY

Prepared For

THE DEPARTMENT OF INDUSTRY, TRADE AND COMMERCE

By

DEMERS, GORDON, BABY LIMITED

System Consultants

February, 1972
Ref: 117/138

TABLE OF CONTENTS

A Study of Computer Utilization in the Canadian Construction Industry

1.0 Introduction

The intent of this study, commissioned by the Department of Industry, Trade and Commerce of the Canadian Government, was to determine the current status of the use of computers by the Canadian Construction Industry and, if warranted, to recommend possible actions by industry and Government directed at increasing the productivity and efficiency of computer use.

The reason for undertaking such a project was to attempt to clarify a situation which has been somewhat subject to speculation rather than analysis. It was recognized by the Department that the computer, when correctly utilized, could be a powerful tool in increasing productivity and efficiency within the industry. However, clarification was required of what role, if any, the Department of Industry or the Construction Industry might play in increasing the effective utilization of the computer.

The study does not pretend to be exhaustive in the sense that it provides an in-depth analysis of the factors affecting the level of usage of the computer by the industry. Nevertheless, it does provide a clear indication of the problem areas and recommends short term and long term courses of action which will be beneficial to the industry.

2.0 Terms of Reference

In order to effectively satisfy the general objectives previously stated, it was necessary, within the given terms of reference for the study, to provide answers to the following:

a) What work functions within the industry are presently being undertaken utilizing the computer and what are the reasons for these applications;

b) What are the existing sources of equipment and software and also, how are the new technological developments in these fields likely to influence future computer utilization within the construction industry;

c) What are the views of the various sectors of the industry concerning the probable role of the computer within their own operations;

d) In what work areas, if any, has the computer been improperly utilized;

e) What role could the computer play in the various work functions of the industry to utilize its potential more fully;

f) What is foreseen as the possible action to be taken to increase the effectiveness of computer utilization.

3.0 Summary of Recommendations

As previously stated, the intent of this study was to determine the current status of the computer within the construction industry and to recommend possible actions that could be taken by industry and Government to increase its utilization.

In order to satisfy these objectives, we must first recognize that there is definite evidence in the industry of an inertia on the part of some of its members against accepting the computer as a viable working tool capable of producing significant improvements in some of their operations.

This feeling apparently has been caused primarily by three major factors:

1. A lack of awareness by industry members of the computer's potential;

2. The aura of mystique that surrounds the computer both in its language and its operation;

3. The lack of user oriented programs and products developed to satisfy specific needs and requirements.

Any recommendations that are contained in this report must therefore be primarily concerned with overcoming these basic problems and they should not be directed solely at one particular industry sector or Government agency. On the contrary, they must ensure that all interested parties become involved, be they users, industry associations, equipment manufacturers, software houses, service bureaus or Government.

Obviously, in making these recommendations, we recognize that implementation priorities must be considered and the proposed actions are thus of two types: those designed to meet the more immediate needs of the situation, i.e. over the short term, and those concerned with more long term solutions.

The following recommendations can be considered as being in the short term category:

1. That the interchange of computer programs be promoted and that information on existing computer facilities and capabilities be disseminated within the industry. These activities appear to be well suited to the aims of the Department of Industry, Trade and Commerce, but, to be truly effective, the active cooperation of industry associations and professional groups must be sought and their assistance obtained.

2. That a study be undertaken to analyse the cost trends resulting from developments in hardware, software and communications technology and determine how these relate specifically to the construction industry in terms of the potential impact on their operations. In addition, efforts should be made to monitor and report on developments in digital data communication services as these can have a significant influence on the costs of computer time sharing services.

3. That industry associations and professional groups be urged to assume the initiative in determining where, within their own industry, sector, or discipline, the computer can be profitably utilized. These efforts could be coordinated by the Department of Industry, Trade and Commerce, and form part of an overall industry promotional program.

The long term recommendations are as follows:

1. That an in-depth analysis of the work functions of each major construction sector and discipline be undertaken to determine those activity areas where the computer could make a significant contribution to increasing productivity and efficiency. This analysis would take into consideration, among other things, the cost/benefit involved, the applicability of existing software, and the possible methods of funding any proposed program development.

2. That a study be undertaken to determine the feasibility of developing a problem oriented language and standardized procedures for handling industry-related problems with the computer. The goal would be to make problem solving with a computer as simple as operating an adding machine.

3. That based on the findings of recommendations nos 1 and 2, suitable steps be taken to develop any special programs or languages aimed at enhancing the effective use of computers in the construction industry.

4.0 Study Approach

Owing to the fact that the time allowed to undertake the study was somewhat limited, it was decided that efforts should be concentrated on a qualitative rather than a quantitative approach to the analysis. This was accomplished by undertaking a series of in-depth interviews instead of distributing a mailed questionnaire to the industry in an attempt to obtain statistically meaningful results.

Using a structured interview guide, the interviews were conducted with individuals, companies and associations representative of the various sectors of the industry in several locations accross the country (see appendix I for sample of the questions).

A total of twenty-three such interviews were held in Montreal, Ottawa, Toronto, Edmonton, Vancouver and Victoria, with groups of architects, consulting engineers, Federal and Provincial Government Departments, manufacturers and suppliers, general contractors, builders and developers, quantity surveyors and industry associations.

Lacking alternative sources of statistics, the interviews were also designed so as to obtain the answers to questions concerning such items as size of organization, area of activity, equipment used, software produced, degree of computer utilization, etc. Fortunately, the persons interviewed exhibited a high degree of cooperation and, because of their patience and understanding, good results were obtained.

In addition to the interviews, an effort was made to obtain information on software programs presently available to the construction industry and to collate them into a reference document complete with an identifying abstract. A partial bibliography was also compiled of literature articles that are concerned with computers in the construction industry. Although this section of the study is not comprehensive, it does provide the interested party with a guide to the available documents from which he may delve further into the subject.

Another portion of the study was a partial tabulation of the available computer services both for dedicated and time shared systems. This analysis of sources enables the reader to identify companies which can provide him with the type of service he requires.

5.0 Summary of Findings Applied to Industry in General

a) Owing to the cyclical nature of the industry, firms find it difficult to engage in long-term planning and development of computer applications that may commit them to invest funds over an extended period of time. When, as in one case, an organization drops from 65 to 15 employees in one year because of lack of projects, they become understantably hesitant about committing funds to the development of computer applications they may be unable to complete or use. This potential lack of continuity inhibits the development and, in many instances, impedes the utilization of new techniques.

b) There does not appear to be a lack of available commercial software packages but the majority of them appear to need modification to suit each specific application. Several people have complained that these packages were not always oriented to the user's approach to problem solving and that those developed by time-sharing companies tended to involve more operating expense than perhaps was necessary.

c) Generally, all parts of the country appear to be well serviced with time-sharing facilities, service bureau, batch processing services and commercial software development firms.

d) One observation that was repeated in several interviews was that equipment and commercial software companies selling to the construction industry do not appear to have considered the problems peculiar to various construction sectors. It was felt that computer representatives with construction management experience

would be more useful to potential customers than those at present who provide generalistic solutions to problems requiring specific answers.

e) The computer languages generally used throughout the industry are FORTRAN for scientific and technical applications and COBOL for the accounting functions.

f) The range of monthly expenditures or costs directly and indirectly associated with the computer range from as little as $200-$300.00 to $65-70,000.00 per month for firms ranging from fifteen employees up to eight hundred employees. In the former case, the expenses were incurred for remote batch processing for project control. In the latter case, the firm spent over 50% of its monthly expenditure for accounting purposes with the remainder being spent on operational functions.

Generally it would appear that respondents have been absorbing the cost of developing special software programs wherever this has been necessary and this cost can be high. One firm spent over $120,000.00 in connection with developments relating to computer utilization for the industry. Unfortunately the timing for such a venture did not appear to be right and most of their work was wasted. Most firms are usually unaware that existing Federal aid programs are available to provide partial assistance in some cases.

g) Where the computer is utilized, it is usually for project planning, budgeting and cost control, general accounting and payroll. There do not appear to be many instances where cost/benefit analyses were undertaken prior to the utilization of computers for such functions, but the results indicate that the cost of processing these work functions is at least economically acceptable to the firms and comparable in cost to their non-computer methods.

h) In the case of engineering firms, particularly those involved in structural design, the computer has had greater acceptance than in other sectors. Many of the firms utilize it to such an extent that they have their own in-house facilities. In the case of architectural firms, the majority use outside batch processing, with only a few instances of in-house terminals or hardware.

i) Only in isolated instances does the individual engineer or technician have direct access to a terminal or computer. The usual procedure in most offices is for the engineer requiring the services of a computer to complete a form tabulating the design requirements or criteria and then to submit it to a specialist for processing.

j) Those computer programs developed by some construction industry associations appear to be successful and fulfill the functions for which they were intended.

k) The larger component manufacturer and supplier has generally utilized the computer in many of his operations and in one instance has developed an extensive

and sophisticated program to meet his own individual needs.

l) There exists within the industry a resistance on the part of many senior managers against the use of the computer for work functions other than accounting. In part, this may be due to the apparently high cost of developing software packages when taking into consideration their relatively short life-span and the cyclic nature of the industry. There is also the difficulty of acquiring sufficient familiarity with the computer field to appreciate fully its potential impact on the operations of the organization. The difficulty is aggravated by the technical jargon used by computer experts which tends to create an air of mystique about the computer.

m) Most of the younger members of the industry have become familiar with the computer during their educational training and want to see their use made more general. However, one concern expressed during an interview by a senior professional was that extensive use of the computer for design tasks may tend to affect the ability of younger professionals to reason and to develop the logical steps leading to sound solutions, thereby reducing their design capabilities.

n) In spite of the above remarks, most people interviewed do not feel that the Canadian construction industry lags behind its counterpart, in other countries in their acceptance of the computer. It appears that,

although other countries talk much about utilization, it is more theory than practice.

o) Respondents were generally vague as to what they see as the future role for the computer in the industry. Such functions as automatic drafting, integrated design and manufacturing, etc., were mentioned, but the large expenditures involved in the development of such techniques and the unknown cost/benefit associated with them was of concern. The feeling is that the size of the investment and its associated risks, placed such developments beyond the capability of most, if not all, individual firms and organizations.

p) There is need of a medium for transmitting information about computer applications within the industry. People are unaware of developments taking place in other companies and there is a tendency to duplicate development efforts. Several architects have spent large sums developing project control packages that in essence fulfill the same functions. Also, some people confided that they were to a large extent reliant on equipment and service salesmen for information on new developments. As a consequence, they are often unaware of the commercial availability of packages from other sources and resources are being spent in developing their own packages.

q) It appears, generally, that members of the industry are not interested in attending seminars on the subject, unless the seminars are specifically oriented to their needs and requirements. Each sector is naturally concerned with its own particular problems and possible solutions.

6.0 Summary of Findings Related to Specific Industry Sectors

6.1 Consulting Engineers

This would appear to be the industry sector which has utilized the computer for the greatest number of work functions. Not only is it employed for accounting, but it is making a significant contribution as a working tool within the design field. This may be, of course, because the design activities of the consulting engineer are particularly suited to equipment capable of performing multitudes of calculations based on known criteria.

The assets expended by consulting engineering companies on computer utilization naturally vary according to size of the organization, but the range is from a several hundred dollars a month to nearly sixty thousand per month, although in this latter case over half of that is spent in undertaking accounting functions.

It is surprising though, that even in this sector of the industry, where the computer has already proven its worth, there exists an inertia on the part of some of the senior members of the industry to accept it as a viable working tool.

Many firms have developed their own software programs, others use commercial packages available both here and in the United States. Only in isolated instances does the individual engineer or technician have direct access to a terminal, and in most of those cases there has been a marked reluctance to take advantage of the opportunity to utilize the facility.

The usual procedure in most offices is for the engineer requiring the services of the computer group, to complete a form tabulating the design requirements or criteria and then to submit it for processing. This request is then handled through an in-house system, a time-sharing or remote job entry terminal or a service bureau.

Due to their exposure to it at University, the younger members of the profession are more willing to accept the computer as a working tool. However, fears were expressed by some persons interviewed, that because of the apparent dependency of the younger engineers on the computer as a mean of solving problems, the possibility exists that they are unable to evaluate the accuracy of results obtained, due of their ignorance of the steps leading to these results.

There is no consensus as to the future use of the computer. Automatic drafting and extending the design programs into a single package to handle everything from the preliminary analysis stage to controlling the fabrication of materials, were cited as possible uses for the computer, but most persons interviewed did not have any well-defined ideas regarding the future role of the computer in the industry.

6.2 Architects

The computer in this sector is being used mainly for accounting and project control. Some architectural firms have expended many thousands of dollars of their own funds to develop new programs or to modify existing packages to produce architectural design programs, but in no firm interviewed were these presently being used.

Once again, the cyclical nature of the industry has a deterrent effect on long-range development; when a firm goes from 65 employees one year to 15 employees the next, it is difficult to engage in meaningful long-range planning.

As with other sectors, the younger professional is more keenly aware of the capabilities of the computer than his older confrere but often he appears concerned with theoretical applications more than the practical solution of problems.

In the area of in-house project control it would appear that by utilizing outside service bureaus it is economically feasible for an office with as few as fifteen staff members to undertake this function by computer. The software employed in some instances was developed in-house by the architectural firm interviewed and in other instances was a modified commercial package. It does appear practical for more firms to employ such computerized techniques in this function, providing the necessary software can be made available to them. The operating costs are as low as $200-$300 per month which for this size of firm would seem to be a reasonable expenditure.

Some firms who have developed their own programs expressed a willingness to make these available to other architects but these offers do not appear to have been accepted. Generally, persons interviewed were interested in the proposed Construction Information System and its relationship to their present computer operations. Although

in-house terminals are not generally used by architects, it would appear that if a general purpose terminal became a component of the CIS, then they might exercise the option of using it for functions other than information retrieval.

It is possible that because of the individualistic nature of the professional engaged in architecture and the not uncommon resistance to commercialism that is encountered amongst them, the acceptance of the computer as an aid in the design and administrative functions will be only reluctantly obtained.

A concerted organized effort originating from within the profession could help in overcoming this resistance.

6.3 General Contractors and Developers

Project control and the various accounting activities common to this sector are the prime work functions undertaken by the computer for contractors and developers. The concept of computer-assisted estimating does not appear to have been developed or accepted by the contractor; this could possibly be due to the system of costing that exists whithin the industry and the variations that exist between firms.

Once again, the industry's traditional conservatism is evident and its reluctance to accept change can be blamed for the negative reaction shown to utilization of the computer.

Another possible reason is the lack of commercially available software developed specifically for the use of the general contractor. There is no doubt that the computer can be effectively used as a project control tool and has been on several projects.

One of the firms interviewed was in the embryonic stage of developing a very detailed and elaborate system for project control. This would involve the analysis of individual work tasks connected with a project and the preparation of detailed control reports. This is to rely heavily on the computer for its implementation.

Also, where there are specific project management teams, the computer is sometimes being employed for project control functions, and contractual accounting.

Naturally, these observations do not apply to some of the larger companies where many are utilizing the computer in their operations, in the accounting and administrative functions. It would seem that an opportunity does exist in this area to identify the specific role of the computer in the general contractor's operations and then to determine the benefits in productivity and efficiency that could be generated if it were more generally employed.

6.4 Quantity Surveyors

The principal computer application in this sector is as a data bank for pricing information.

The quantity surveying group within one provincial government department have developed a comprehensive program for:

1. assembling and updating a library of unit cost information

2. Estimating costs of construction by utilizing the library unit cost figures together with the unit dimensions.

This is a positive step towards computer-assisted estimating, but as yet it has not been generally utilized by the private sector. One known exception will be described in the section of this report dealing with manufacturers.

Furthermore, no known developments are underway to employ the computer in the "take-off" process. This very time-consuming, costly activity is still undertaken manually, without any true assurance of accuracy or consistency. It would appear that this is another field where research and development work could produce great benefits for the industry as a whole.

6.5 Industry Associations

In the case of at least one industry association an extremely progressive approach to computer utilization has been adopted. Working with their industry sector, in this case the structural engineers, the institute identified possible areas in the analysis and design field where a program specifically developed by them would provide the engineer with a more efficient method of solving a particular problem.

After debugging the program and ensuring that it was in fact a viable proposition, the institute organized a series of seminars throughout the country for the information of interested parties. The next step was to have qualified personnel available regionally to assist engineers in using the programs.

The promotional techniques employed by this particular institute have proved to be very effective and it would appear that their efforts have made a substantial contribution towards furthering computer use by the structural engineering group.

This program is being treated as an evolving project, new software packages are being developed and older ones modified, thus ensuring that the industry does not lag in any way behind similar groups in other countries.

The case demonstrates that there is a role for national associations in the promotion of new technology within their industry sectors. This development, incidentally, was financed by the institute members themselves without any recourse to gevernment aid.

6.6 Manufacturers and Suppliers

Each of the companies interviewed uses the computer in a variety of functions within their organization. These include:

Accounting
Inventory control
Invoicing
Cost distribution
Operations research

Market forecasting
Sales estimating
Shop processing
Salary analysis
Order processing
Payroll
Research
Engineering
Cash flow analysis

As can be seen, EDP plays a considerable role in the activities of these firms and large sums are spent yearly on the development of new programs, updating of older programs and for rental or purchase of equipment. One comment was that in view of the large sums expended by each individual company, perhaps some cooperative venture could be organized which would avoid much of the duplication of equipment and programs. At the same time, it was felt that such a move could encourage the acquisition of more powerful computers capable of performing more extensive functions.

The one company that has developed the sales estimating and shop processing programs has definitely attained a unique position in the industry. The value of the work is recognized internationally and already the programs are being utilized by companies outside of Canada.

Normally, commercial packages are used by these companies, either in their original form, or else modified to suit individual requirements; however, in some instances, programs have been developed in-house for specific functions.

The future role for computers as far as the manufacturer and supplier are concerned is to extend the existing functions and, as one manufacturer stated, use them more extensively in the scientific and technical field.

6.7 Government Departments / Agencies

Within the government departments and agencies contacted, the computer is not being utilized as extensively as one would expect. Considering the dollar value of construction undertaken by these bodies, it plays a minor role in performing most of those work functions directly related to construction.

One area where the computer could possibly be utilized to a greater advantage is in detailed project control. Such systems as do exist within government bodies are rather general in their design and may not provide the same degree of control as exhibited by some of the systems within the private sector.

One of the departments surveyed uses the computer for some in-house design functions and for the preparation of master specifications. This latter application is in the early stages of development.

Another government department uses the computer successfully for the preparation of budget estimates as described in the quantity surveying section of this report. This program is available to other government departments and agencies who are interested in its use.

In general, the exchange between government departments and agencies of successfully developed programs, as in the above

case, should be encouraged. This would yield the double benefit of stimulating a greater and more effective use of the computer for construction related work functions and reduce costly duplication of computer program developments.

To a certain degree, the utilization of the computer is inhibited by the same type of inertia amongst the more senior members of the departments, as is exhibited within the private sector.

It is anticipated that as the volume of government construction increases over the years, the computer will be called upon to play a larger role in managing the projects and assisting in performing many of the work functions presently done manually.

7.0 Operating Systems and Computer Languages

A large variety of computer systems are available today to serve the varied needs of the industry. Individual firms can have access to these facilities either through rental of time from one of the many commercial service bureaus across Canada or, if the level of usage justifies it, by acquiring the necessary facilities in-house.

Use can be made of these systems under three modes of operation:

a) batch processing where the user prepares the program or data on punched cards or other suitable media, delivers it to a computer centre (commercial or company owned) where it is processed and the output returned to him at a later time;

b) remote job entry which is a variation of batch processing where the user has on his premises suitable equipment such as a punched card reader which is connected to the computer centre; the user enters his data on this terminal for processing at a later time by the centre and the output is returned to him, either on the terminal, or by transportation from the centre;

c) time-sharing, where the user has on his premises a terminal which gives him direct access to a computer which allows for immediate execution of his program or processing of his data.

The computer, no matter how powerful, is of no use without programs. These programs are a series of instructions to the computer which tell it how to treat each bit of information. Such programs are time-consuming and consequently expensive to prepare if they are written in what is called "machine or assembly language". To overcome this difficulty and to ease the task of preparing programs, a great variety of "more user-oriented languages" have been developed. These languages permit the preparation of programs through relatively simple instructions which are translated in the computer into more complex operations. ALGOL, APL, BASIC, COBOL, FORTRAN and PL1 are among the better known of these languages. Of these, the two languages most often used by the construction industry are FORTRAN and COBOL, the first for scientific and technical applications and the second for accounting functions.

In addition, many special programs have been prepared by equipment manufacturers, service bureaus and private organizations to solve certain classes of problems. These programs are usually referred to as "packages" and are offered by service bureaus for use by their customers, or are sold or leased for use on in-house equipment.

The value of a package lies in the programming time which it saves. However, they tend to be either very general-purpose so that no modification is required by the user (which, in general, imposes a penalty in the form of a higher-than-needed overhead of unnecessary computations), or to be so specific that each user has to modify it to obtain the needed results.

Additionally, it takes time to get to know a package sufficiently well to use it correctly and the inexperienced user

may often need a computer specialist as intermediary between his needs and the program. These factors tend to discourage the construction expert from using the computer and from keeping abreast of developments in this field which could be of assistance to him.

Recognizing this problem, some packages have been deliberately designed for the relatively inexperienced user by having the program accept commands which are part of the every-day language of the user. In this way, the package becomes a problem-oriented, or user-oriented language, perhaps for a specific function such as structure analysis.

Fortunately, with such developments, the user can become increasingly more remote from computer-dependent program requirements as the new problem oriented and high-level* languages permit him to define a problem solution in terms familiar to him, rather than those required by the machine. Many man-years of effort on the part of the computer industry now permit the user to concentrate on the definition of the problem solution rather than the details of how the computer will solve the problem.

This enhanced capability is thus coming about as a result of three major developments:

a) the proliferation of special "packages" designed to solve specific problems

* A high-level language is one which requires fewer user-generated instructions to produce a given series of computations. It allows a user to concentrate on the solution definition without considering the computer characteristics.

b) the development of problem-oriented languages designed to facilitate programming in specific problem areas, usually using the terminology applicable to the area

c) the development of high-level general-purpose languages providing an enhanced capacility over the languages of the 50's and 60's.

Conclusion

It is believed that increased utilization of computers in the construction industry will be favoured when it is no longer necessary for the construction specialist to learn a different procedure, unrelated to his problem area, for each application he wants to make of the computer. To him, using the computer must be made nearly as easy and routine as using a slide rule, calculator or telephone.

8.0 Trends in Computer Technology

Computer technology is advancing at a rate which leads to doubling of the performance available per dollar about every three years. Other estimates place the improvement factor at five to ten every five years. These changes arise from improvements in production techniques as well as changes in the technology employed.

Consider, for example, the capability available in 1972. It is now possible for a group of users to arrange for access to a computer 8 hours a day, 5 days a week, at quite low costs. Present technology permits this to be obtained for some $300 per month per participant, with access using programming languages such as FORTRAN or BASIC with a reasonable size of file storage per user. This cost per user would include the terminals and salary cost of an operator.

By 1975, a similar expenditure should be able to obtain access to a system twice as powerful or permit almost twice as many users to be on-line with a correspondingly lower cost per user.

This increasing capability for every dollar invested on equipment can be realized by the user who has the knowledge and resources to use the computer directly. However, because of the contrary trends in wage costs, the user who must rely heavily on the personnel of commercial computer centre for support in the preparation of programs and other such assistance, will be unable to obtain much advantage from these decreasing equipment costs.

The economic utilization of remote facilities is greatly influenced by the amount of data and the speed with which it must be transmitted. This cost has not followed a comparable downward trend but it is expected that significant changes in cost structures and services should occur over the next several years. This will allow greater use of facilities no matter where they are located, further reducing the cost of duplicating similar facilities in many centres.

To these factors must be added the evolution of programming languages and packages discussed in the previous section which, taken together, will generally render computer facilities more economical to use, more available to users and more specifically oriented to their needs.

To summarize the trends in the cost and performance of computer equipment:

a) Usable processing speeds are increasing by factors of 5 to 10 every 5 years

b) The cost of main memory storage is decreasing by factors of 2 to 5 every 5 years, with some forecasts calling for even more rapid decreases in the future

c) The cost of bulk data storage is decreasing by factors of 10 to 100 every 5 years

d) Overall cost per instruction performed is decreasing at rates of 5 to 10 times every 5 years.

Not all these changes will have an equal impact on the processing needs of the construction industry. The larger bulk-storage cost-reductions apply mostly to very large storage devices which may not be needed in construction industry applications, while the major gains in processing speed may also be only partly relevant. In particular, the more applications assistance the user requires, the more the effect of increasing salary costs will offset gains in the efficiency of raw computing power.

9.0 How the Industry's Needs Can Be Met

This report has discussed some of the main features or peculiarities of the industry which influence the degree of utilization of the computer by the construction industry. They may be restated as follows:

a) The industry is cyclical in nature both in terms of overall volume fluctuations and in terms of the nature of projects

b) As a result of this fluctuation, expertise developed in the use of a specific "package" program may have a short life span, thus rendering long-term computer program development by individual firms economically difficult to justify and possibly inappropriate.

c) The nature of the required computer applications spans the range from accounting and project control to design calculations, computerized drafting, information retrieval on products, drawings, personnel, etc.

d) Computer languages commonly used by the construction industry are more machine-oriented than problem-oriented. This precludes greater use of computers since in most cases an intermediary is required between the computer and the construction specialist.

From these observations it may be concluded that:

a) Certain applications are not economically justified when undertaken by a single organization. Information retrieval,

when applied to product characteristics, must be developed on a cooperative basis as is proposed for the Construction Information System. It is also likely that software development for applications such as computerized drafting and other specialized functions should be undertaken on a cooperative basis.

b) For the more general applications, it appears that, except in a few instances, the available packages have not provided the required solution and commonly used languages are either too expensive, or inappropriate for extensive use by most of the industry. The alternative approach is to develop and promote either problem-oriented programming languages or a more powerful general-purpose language.

The Department of Industry, Trade and Commerce and others could therefore assist the construction industry in the following ways:

As an Interim Measure:

1. That the interchange of computer programs be promoted and that information on existing computer facilities and capabilities be disseminated within the industry. These activities appear to be well suited to the aims of the Department of Industry, Trade and Commerce, but, to be truly effective, the active cooperation of industry associations and professional groups must be sought and their assistance obtained.

2. That a study be undertaken to analyse the cost trends resulting from developments in hardware, software and communications technology and determine how these relate specifically to the construction industry in terms of the potential impact on their operations. In addition, efforts should be made to monitor and report on developments in digital data communication services as these can have a significant influence on the costs of computer time sharing services.

3. That industry associations and professional groups be urged to assume the initiative in determining where, within their own industry, sector, or discipline, the computer can be profitably utilized. These efforts could be coordinated by the Department of Industry, Trade and Commerce, and form part of an overall industry promotional program.

The long term recommendations are as follows:

1. That an in-depth analysis of the work functions of each major construction sector and discipline be undertaken to determine those activity areas where the computer could make a significant contribution to increasing productivity and efficiency. This analysis would take into consideration, among other things, the cost/benefit involved, the applicability of existing software, and the possible methods of funding any proposed program development.

2. That a study be undertaken to determine the feasibility of developing a problem oriented language and standardized procedures for handling industry-related problems with the computer. The goal would be to make problem solving with a computer as simple as operating an adding machine.

3. That based on the findings of recommendations nos 1 and 2, suitable steps be taken to develop any special programs or languages aimed at enhancing the effective use of computers in the construction industry.

APPENDIX 1

SAMPLE OF QUESTIONNAIRE

APPENDIX 1
SAMPLE OF QUESTIONNAIRE

CONSTRUCTION INDUSTRY COMPUTER APPLICATIONS STUDY - DEPT. OF INDUSTRY TRADE & COMMERCE

1.0 INTERVIEW GUIDE

PART I - General

1.1 Company or partnership name

1.2 Address Tel. No.

1.3 Principal field of activity

1.4 Person interviewed

1.5 Position

1.6 No. of employees in organization

1.7 Approx. Sales Volume - Sales

Fees

1.8 Are computers utilized in any work function in organization

2.0 PART II - Utilization

2.1 What functions are they performing -

.Project Control - Inhouse activities
- Contractual activities

.Design - Architectural
- Engineering

.Detailing

.Surveying

.Simulation

.Accounting - General
- Payroll

.Other

2.2 Are the functions performed by -

.Dedicated System in house

.Dedicated System shared

.Commercial time sharing

.Private time sharing

.Remote Batch processing

.Other

2.4 If outside service, name -

2.5 Previous experience concerning utilization -
Have you ever performed other functions with computer which were not successful.

2.6 If yes , what were they, and where did you desist?

2.7 Do you intend extending the functions performed by the computer?

2.8 What prompted your organization's initial verture into EDP?

- Equip. manufacturers representations
- Awareness - magazine, articles, etc.
- Past experience with other organizations
- Prestige

2.9 Were any cost/benefit studies undertaken before the introduction of the computer?

2.10 Do you know of any organizations in your area of activity utilizing the computer?

2.11 Would you be interested in attending or having your staff members attend seminars on computer useage?

2.12 How do you or your staff acquire knowledge on the use of the computer - its functions and how it is operated?

PART III - Costs

3.1 If your system is a commercial T.S. what is the monthly charge?

3.2 If dedicated system - rental cost
- capital expenditure

3.3 Approximate cost of installation, including air conditioning, flooring, electrical, etc.

3.4 Approximate cost of dedicated staff - particulars including numbers

3.5 Approximate amount spent on software
- in-house
- commercial packages
- custom commercial packages

3.6 Did you undertake detailed cost/benefit studies before extending its usage?

3.7 Any details on these cost/benefit studies?

3.8 Do you sell any of your computer services -

- Project planning
- In-house developed software

3.9 If yes , approx. revenue

3.10 Are computer operating capital charges assigned to general o/h or to specific projects

PART IV - Equipment

4.1 What is the nature of the equipment employed in-house?

Ascertain the manufacturer.
Model No. & Type
Nature of tape drives & numbers
Nature, capacity & no. of disc files
Line printers speeds
Card readers & punch speeds
Any other equipment
- Paper tape readers
  Drum storage
  CRT Displays
  Drum or flat bed plotter

4.2 Remote batch facilities

- type
- model
- card reader punch speeds
- line printers speeds
- any auxiliary storage Equipment

4.3 Remote terminal equipment

- type
- model & No.
- connected to what equipment
- The T.S. facility name

PART V - Software

5.1 What programming languages are employed in your companies operations?

5.2 What areas were they used for programming in last year?

5.3 Over one year ago?

5.4 What packages does your company employ?

5.5 From whom were these obtained

5.6 At what cost?

5.7 Were they modified

- in-house
- outside if so by whom

5.8 How did you hear of these packages

5.9 Have you developed any special packages
If so give short description

5.10 Who undertakes your programming

5.11 Have you evaluated any outside software packages which you subsequently did not use, if so, why were they unsuitable.

5.12 What do you feel is the reason for not using commercial packages

- lack of application orientated language
- cost of processing
- need for custom orientated applications

5.13 Who do you know has commercial software packages available for use in construction industry applications

5.14 Is there a need for more promotion of commercial packages orientated towards your area of activity

PART VI - Opinions

6.1 What do you see as the future for the computer in the industry

6.2 Are you interested in participating in any seminars promoting its use

6.3 Do you feel that any outside agency should be doing more to promote its use:
- associations
- government
- joint venture groups

6.4 Do you feel that persons presently entering the industry are sufficiently knowledgeable in the field of EDP

6.5 How can members of your organization who may not be familiar with EDP become familiar with the computer, or is there any such need

6.6 Do you feel that the Canadian Construction Industry lags in the field of computer utilization as compared with other countries.

6.7 How do you personally keep abreast of developments in computer technology, equipment, and software

6.8 Would you prefer to have a computer specialist who was familiar with construction technology or construction personnel who were computer-orientated.

APPENDIX 2

AVAILABLE COMPUTER SERVICES

APPENDIX 2
AVAILABLE COMPUTER SERVICES

The enclosed list of services available is a partial compendium of the type of computer service available in Canada, as of early 1972. It should be noted however, that some companies are listed only by their main address, when in actuality they make available a variety of services at several locations across the country.

The following coding is employed:

B. Batch Processing.
Where programs and/or data are collected into groups for processing rather than being run as soon as submitted. Usually provided by a local service bureau.

R. Remote Job Entry.
An extension of Batch Processing whereby programs and/or data can be entered at a location remote from the computer and the results obtained at a later time either on the terminal or by transportation from the computer centre.

T. Time Sharing.
Access to a computer from a remote location which allows for immediate execution of a program. For large programs, provisions for print-out at the computer may be made, providing a similar capability to Remote Job Entry.

We wish to acknowledge the kind permission of Maclean-Hunter Ltd. in permitting us to copy the information contained in the December 1971 issue of Canadian Data Systems - Products and Services - Computing and Data Processing Service. Our apologies for any typographical errors which may have crept in during the copying process.

	B	R	T
Addressograph-Multigraph of Canada Ltd. 43 Hollinger Rd. Totonto, Ontario		R	
Angus, R., Computer Services Ltd. 800 McLeod Bldg. Edmonton, Alta.	B		
Aquilla BST Suite 4,000, Place Victoria Montreal, P.Q.	B	R	T
Argus Computer Applications Ltd 222-227 Johnson St. Victoria, B.C.	B	R	
Associated Computer Services Ltd. 1111 W. Hastings St. Vancouver, B.C.	B		
Can-Am Systems Ltd. 1112 W. Pender St. Vancouver, B.C.	B		
Canadian Data Centre Ltd. 181 Eglinton Ave., Suite 300 Toronto, Ontario	B		
Canadian General Electric Co. Ltd. 214 King St. W. Toronto, Ontario	B	R	T

	B	R	T
Cogena Inc. Suite 1450, 110 Crémazie Blvd. W. Montreal 351, P.Q.	B		
Com-Share Ltd. 41 Voyager Court N., Rexdale 605, Ontario	B	R	T
Com-Tron Systems Ltd. 560 Wellington St. London, Ontario	B		
Comcheq Services Ltd 447 Portage Ave. Winnipeg, Man.	B		
Compscan Ltd. 737 Church St., #202 Toronto, Ontario	B		
Compu-Share Data Centre Ltd. 800 Portage Ave. Winnipeg, Man.	B		
Computel Systems Ltd. 1200 St. Laurent Blvd. Ottawa, Ontario KIK 3B8	B	R	
Computer Sciences Cda Ltd. 1200 Eglinton Ave. E. Don Mills, Ontario	B	R	T

	B	R	T
Computeraid Systems Ltd. 1468 Victoria Park Ave., Toronto, Ontario	B	R	
Computing Devices of Canada Ltd. Box 508 Ottawa 4, Ontario	B	R	T
Consolidated Computer Ltd. 50 Gervais Dr. Don Mills, Ontario			T
Consumers' Computer Ltd 19 Toronto St. Toronto, Ontario	B	R	
Cover-All Computer Services Ltd. 1468 Victoria Park Ave. Toronto, Ontario	B	R	T
Cross Canada Computer Systems Ltd. 1234 W. Hastings St. Vancouver, B.C.	B	R	
Cygnet Computer Services Ltd. 5315 Décarie Blvd. Montreal 248, P.Q.	B		
Cytronics Corp. 760 Crémazie W., 3rd Floor, Montreal, P.Q.	B		

	B	R	T
M. J. Data Consultants Ltd. 501-237-7th Ave. S.W. Calgary, Alta	B		
Datacap Ltd. 224 Laurier Ave. W. Ottawa, Ontario K1P 5J8	B		
Datacrown Ltd. 120 Bloor St. W. Toronto, Ontario	B	R	T
Dataline Systems Ltd. 40 St. Clair Ave. W. Toronto, Ontario	B	R	T
Datamation Div., Symbionics Systems Ltd. 140 - 1st Ave. S.W. Calgary, Alta.	B	R	T
Datapak Ltd. 69 Queen St. E., Suite 4, Toronto, Ontario	B		
Dataphonics Ltd.- Remote Computing Services 600 - 6th Ave. S.W. Calgary, Alta.	B	R	T
Datapro Ltd. 387 Richmond St. London, Ontario	B		

	B	R	T
Datatech Inc. 155 Bates Rd. Montreal, P.Q.	B		
Digital Equipment of Canada Ltd. 150 Rosamond St. Carleton Place, Ontario			T
EDP Industries Ltd. 1132 Homer St., Vancouver, B.C.	B	R	T
Farrington 1320 Ellesmere Rd., Unit 3 Scarborough, Ontario	B		
Harrow Group Ltd. 2450 Victoria Park Ave. Willowdale 425, Ontario	B	R	
Honeywell Information Systems 2025 Sheppard Ave. E. Willowdale, Ontario			T
IBM Canada Ltd. 1150 Eglinton Ave. E Don Mills, Ontario	B	R	T
Infopro Ltd. 9 Clintwood Gate Don Mills, Ontario	B		

	B	R	T
Information Processing Services Ltd. 2625 Dewdney Ave. Regina, Sask.	B	R	
International Computers of Canada Ltd. 199 Bay St. Toronto 116, Ontario	B		
Jonergin Co. Inc. 6200 Grand Allée St. Hubert, P.Q.		R	
Kurtz & Steel Ltd. 2275 Speakman Dr., Sheridan Park, Ontario	B	R	T
Lakehead Data Centre Ltd. 309 Chapple Bldg. Thunder Bay, Ontario	B		
MICR Systems Ltd. 600 Eglinton Ave. E. Toronto, Ontario	B		
Mackie & Co. Ltd. 377 Colony St. Winnipeg, Man.	B		

	B	R	T
Manpac Data Centres Ltd. 2000 Ellesmere Rd. Scarborough, Ontario	B		
McKay Systems Corp. Ltd. 606 - 1112 W. Pender Vancouver, B.C.	B	R	
McMullen, D.E., & Associates Ltd. 250 Bloor St. E Toronto 285, Ontario	B		
McPherson Scott Ltd. 79 Ellesmere Rd. Scarborough, Ontario	B		
Metra-Informatique Canada Ltd. 700 Lagauchetière W. Montreal, P.Q.	B	R	
Metro Systems Professional Services 234 Eglinton Ave. E. Toronto, Ontario	B		
Multiple Access General Computer Corp. Ltd. 885 Don Mills Rd. Don Mills 403, Ontario	B	R	T
National Cash Register Co. of Canada Ltd. 222 Landsdowne Ave. Toronto, Ontario	B		

	B	R	T
Nfld. & Labrador Computer Services Ltd. Elizabeth Towers, 100 Elizabeth St. John's, Nfld.	B	R	T
Offad Ltd. 6 Thorncliffe Square Toronto, Ontario	B		
Phillips Computing & Keypunch 5075 Yonge St. Willowdale, Ontario	B		T
Pica Data Services Ltd. Box 727 Galt, Ontario	B		
Polycom Systems Ltd. 1300 Don Mills Rd. Don Mills, Ontario			T
PolyVen Management Ltd. 1300 Don Mills Rd. Don Mills, Ontario	B		
RCA Ltd. 21001 N. Service Rd. Ste Anne de Bellevue Quebec, P.Q.	B	R	T
Rapid Data Ltd. 208 Cambridge Bldg. Edmonton, Alta.	B		

	B	R	T
Real Time Corp. Ltd. 797 Don Mills Rd. Don Mills, Ontario	B		
J. L. Renaud & Associés Inc. 800 Dorchester Blvd. W., Suite 1230 Montreal, P.Q.	B	R	
SCL Systems Corp. 16700 Trans Canada Hwy, Kirkland, P.Q.	B	R	T
SDI Associates Ltd. 45 St. Clair Ave. W. Toronto, Ontario	B		
SMA Inc. 700 Lagauchetière W. Montreal, P.Q.	B	R	T
SNC Computation Ltd. 1550 de Maisonneuve W. Montreal, P.Q.		R	
Saanes Computer Publications Ltd. 25 Wellington St. W. Toronto, Ontario	B		
Satellite Computer & Communication Systems Ltd. 200 Glendale Ave., Box 30 Hamilton, Ontario	B	R	T

	B	R	T
Setak Computer Services Corp. Ltd. 20 Spadina Rd. Toronto, Ontario	B	R	T
I.P. Sharp Associates Box 71, Toronto Dominion Centre Toronto, Ontario	B		T
Skil-Share of Ontario Ltd. 55 Yonge St., Suite 502 Toronto 215, Ontario	B		
Symbionics Systems Ltd. 550 Berry St. Winnipeg, Man.	B	R	T
Systems Dimensions Ltd. 770 Brookfield Rd. Ottawa, Ontario KIV 6J5	B	R	T
Systems Selections Ltd. 1262 Don Mills Rd., Suite 17 Don Mills, Ontario	B		T
Teledisc Systems 304-261 Fort St. Winnipeg, Man.	B		
Trans-Canada Computer Utility Ltd. 800 Dorchester Blvd. W. Montreal, P.Q.	B	R	T

	B	R	T
Tronics Inc. 6600 Cote des Neiges Montreal 249, P.Q.	B		
Tymshare Canada Ltd. 40 Wynford Dr. Don Mills, Ontario			T
Unicon Data Services Ltd. 246 - 2nd Ave. Kamloops, B.C.	B	R	
University Computing Canada Ltd. 1460 Don Mills Rd. Don Mills, Ontario			T
Wang Laboratories Inc. 180 Duncan Mill Road Don Mills, Ontario			T
Western Computing Ltd. 503 Bakes Centre Edmonton, Alta	B		
York Data Centre Div. of P.E.F. Management Ltd. 2450 Victoria Park Ave. Willodale 425, Ontario	B		

APPENDIX 3

PARTIAL BIBLIOGRAPHY OF ARTICLES RELATED TO COMPUTER USAGE IN THE CONSTRUCTION INDUSTRY

APPENDIX 3

Partial Bibliography of Articles related to Computer Usage in the Construction Industry

Architectural questions of the seventies, L.D. Amdahl, Datamation 16:66 - 8 January 1970

Can a computer finally lick the age old problem of cost estimating?, House and Home, 37:34, May 1970

Computer-Aided architectural planning, T. Willoughby and others, Operational Research Quarterly 21:91-8 March 1970

Computer-Aided construction management system, A.C. Brooks and S.J. Fenves, Construction Review 16:4-7 July 1970

Computer-Aided design, is it for you?, E.F. Pain, Business Management 36:24+ May 1969

Computer-aided design; tete-a-tete between man and his machine, Business Management 36:27-8 May 1969

Computer aids Builders, Engineering News-Record 184:17 January 29, 1970

Computer application by a concrete block manufacturer, R.E. Struzziero Management Accounting 52:34-8 May 1971

Computer Graphics 70, N.S. Foy, Datamation 16:114 July 15, 1970

Computer hookup used on construction sites, Engineering News-Record 185:34 August 13, 1970

Computer-oriented construction management system in a public works grant-in-aid program, C.I. Suplee, flow charts, Construction Review 17:4-13 July 1971

Computer package aids systems engineering (SWAPSO), T. Utsumi, Oil and Gas Journal, 68:100-5 June 8, 1970

Computer program helps chooseequipment, Engineering News-Record 178:26-8 June 29, 1967

Computer role needs help, DOD - industry meeting told, W. Bohne, Electronic News 14:44 October 27 1969

Computers at the drawing board, Iron Age 203:98-9 June 12, 1969

Computers in R&D and engineering - proceed with care, L.S. Hill, Research Management 13:191-200 May 1970

Contractor's small computer helps control costs, test ideas, Engineering News-Record 177:88-90 December 15, 1966

Credit Card/EDP control of engineering drawings, L.E. Houk, Management Accounting 51:45-7 August 1969

CSI plans automated specifications system, Engineering News-Record 185:13 July 2, 1970

Data Index System estimates costs (Esso), J.J. Bollwark and D.F. Hagan, Oil & Gas Journal 68:138-9 August 3, 1970

Demand, outside competition spur construction automation, Industry Week 170:21-2 July 12 1971

Design Analysis trend sparks SDRC program, J. Wessling, Electronic News 15 sec 2:66 May 4 1970

Desk-top computer part of new system (Hewlett-Packard 9100B), Engineering News 183:45 October 16 1969

DPMS for multiple project control, F.H. Lutter and R.L. Helstrom, Financial Executive 38:32-6 July 1970

Drawings by Computer cut piping costs, Chemical Week 107:75 July 15, 1970

Electronics boost estimators' output to $1 million per man-day on buildings, Engineering News 186:107 June 17 1971

Expo '67 follows critical path; a computer-oriented technique helps keep construction of a world exhibition on schedule, Business Automation 14:40-4 March 1967

Fast Estimates, Engineering News 181:51 November 7, 1968

Geometric programming helps short-cut those tricky tradeoffs, Industry Week 166:22-3 January 19 1970

How high to rise (economic analyses by computer for architects in Houston, Tex, high-rise office building commission) C. Thomsen, Appraisal Journal 34:585-91 October 1966

Instant Drawings Cut Drafting Costs, Steel 164:41 June 16 1969

Machine-aided drafting system digitized symbols, H.N. Lerman, Datamation 13: 49-52+ January 1967

Major builder links facilities with network, Data Systems News 11:33 June 1970

Materials Management; you don't have to be big to act big, Purchasing 66:70-2 June 26, 1969

Navy computers estimate building costs, Engineering News 180:74 June 13, 1968

New Construction program, products developed by IBM, Electronic News 15:46 April 27, 1970

Order processing cut four weeks by computer (produce finished engineering drawings faster), Steel 160:96h+ February 13, 1967

Pen that floats puts zip in drafting, Business Week p50 January 24, 1970

Procurement Documentation to be offered by DCA labs, J. Vincler, Electronic News 14:27 July 21, 1969

Productivity trends guide job-site cost controls, Engineering News 186:18 May 6, 1971

Small computer said to fill needs of design engineering, C. Black, Electronic News 14:45 May 12, 1969

Small computers key to integrated design, Steel 164:36j May 19,1969

Space age designing (putting the design process on to computers) Economist 222:431-2 February 4, 1967

Spec writers look at the future; some shudder, Engineering News 186:66 June 17, 1971

Spec writers told to automate to stay alive, Engineering News 180:36-7 June 6, 1968

Systematic design formed to supply drafting software, D. Williams, Electronic News 15:28 February 23 1970

Take-off on SCAN, Data Systems News 9:14 September 1968

This computer program can put you on the path to better management and higher profits (Consultion is the joint working of William R. Smolkir of New Orleans and the Fabricated products division of Allied Chemical Corp.), House & Home 31:102-6 March 1967

To each engineer, his own computer (Apache), Chemical Week 106:73-4 March 18, 1970

To handle the mounting flow of technical data specification writers urged to automate, Engineering News 176:21 June 2, 1966

APPENDIX 4

SUMMARY OF AVAILABLE SOFTWARE PACKAGES

APPENDIX 4

SUMMARY OF AVAILABLE SOFTWARE PACKAGES

As with the bibliography, this compendium of software packages is not intended to be comprehensive. The most readily available sources were used, but no attempt was made to ensure that replies were obtained from all groups contacted or to identify all possible sources. In most cases, the source is a computer manufacturer or service bureau, which leaves out the many in-house developed packages prepared by consultants, architects, contractors, etc. Nevertheless, the partial compendium lists, in alphabetical order, over 260 packages, some of which are similar packages available through several sources.

ACI COLUMN REDUCTION FACTORS

Technical Programs, Inc.

AIRPORT PAVEMENT DESIGN

For determining flexural stresses in a concrete pavement for loads on aircraft landing gear for various configurations; based on Westergaard's analysis for loads at the interior of a slab supported by a dense liquid subgrade.

UNIVAC.

AMECO

Structural analysis: concrete and steel. Automated design and specifications preparation.

Computel.

ANALYSIS AND DESIGN OF CONCRETE WALL-BEAM FRAMES

To carry out an elastic analysis (for member-end forces) of a multi-story, single bay wall-beam which forms a part of a staggered wall-beam structure.

UNIVAC.

ANALYSIS AND DESIGN OF FLAT PLATES AND CONTINUOUS CONCRETE FRAMES

The program provides the findings of the analysis (moments and shears) and the resulting stresses. It compares them with the allowable stresses for flexure and shear. It also provides the required reinforcement (number, diameter and length of bars), quantities for cost estimates and deflections.

SNC, PCA, SDL and UNIVAC.

ANALYSIS AND DESIGN OF SIMPLE-SPAN PRECAST-PRESTRESSED HIGHWAY OR RAILWAY BRIDGES

This program performs the analysis and design of simple-span precast-prestressed highway or railway bridges. The program will accommodate the composite and noncomposite sections. It will compute and print out the following: section properties, dead load and live load reactions, shears and moments required and provided, spacing of shear reinforcement, horizontal shear stress between the composite slab and precast member, midspan elastic deflections for various loading conditions, and the number and center of gravity of prestressing strands required.
UNIVAC, Portland Cement Association, SNC and SDL.

ANALYSIS OF CAPITAL INVESTMENT

Computation of tables of depreciation, salvage values, earnings and interest payments of a project, to determine rates of return.
SWR.

ANALYSIS OF CONTINUOUS GIRDERS (ANGIR)

The ANGIR program analyzes statically loaded continuous beams on unyielding supports, and calculates moments and shears at specified points along the length of the beam. The program output may be used to rapidly draft shear and moment diagrams of continuous girders.
Multiple Access Ltd. and CDC.

ANALYSIS OF MULTI-STORY-FRAMES (MUST)

The KANI-method is used to calculate bending moments in Thru-Floor-Type rigid frames with constant moment of inertia.
SNC

ANALYSIS OF STORM SEWERS

Flow, ratio of depth of flow to the diameter and required pipe sizes are calculated for a three-type system of sewer pipes. Length, slope and drainage area are considered in the calculations.
SNC.

ANALYSIS OF THREE-SPAN BEAMS FOR MOVING LOADS

Technical Programs Inc.

ANGLE ADDITION AND ERROR CALCULATION

Adds positive or negative angles in degrees, minutes and seconds. Also compares the sum of angles to (N-2) 180 which gives the correction for interior angles.

Wang.

ARCH DAM STRESS ANALYSIS (TRIAL LOAD)

The trial load method, as developed by the United States Bureau of Reclamation, is used as a basis of this programming system. The system is completely flexible and can handle single and full adjustments for single or double curvature arch dams of any shape.

SNC.

AREA OF A TRAVERSE

Wang.

ARK01

Random selection method of space allocation

SWR.

AUTOMATED SPECIFICATION WRITING SYSTEM

Alphatext.

AUTOMATIC DESIGN OF REINFORCED CONCRETE STRUCTURES (AMECO)

The AMECO system was primarily developed to be a design program and oriented towards drafting office use. The AMECO system enables a structural engineer, by giving as few as 50 commands to the computer, to implement fully automatic design of a structure with 500 members. The design capability of the AMECO system ranges from completely automatic design for the structure with very little information specified by the engineer, to an analysis of the structure which has been completely described.

SNC and PCA.

AZIMUTH TO BEARING

Converts north or south azimuths to bearing and quadrant.
Wang.

BACKWATER IN ARTIFICIAL CHANNELS

Similar to Backwater in Natural Channels but takes into account singular as well as friction headlosses. Prismatic and non prismatic sections may be considered.
SNC.

BACKWATER IN NATURAL CHANNELS

This program is intended for backwater computation in a natural channel under various discharges. Friction headlosses only are taken into account.
SNC.

BEAM ANALYSIS

Technical Programs Inc.

BEAMCOL

BEAMCOL performs the bending analysis of single-span beam-columns. The beam-column can have a variable cross section and any stable combination of support conditions. The solution is obtained using integration and finite-difference techniques. The analysis yields internal forces, displacements, and stresses.
CDC.

BEARING - BEARING INTERSECT

Solves intersection and lengths of two lines whose bearings are known, given starting and ending coordinates, and the bearing of each line.
Wang.

BEARING - DISTANCE INTERSECT

Solves intersection of two lines, given bearing of the first, length of the second and starting and ending coordinates. Unknown bearing and distance are calculated.

BEARING TO AZIMUTH

Converts bearing and quadrant to north or south azimuth.
Wang.

BELSPRING

BELSPRING provides a simplified design and analysis solution for conical-disc springs or, as they are sometimes called, Belleville springs.
CDC.

BEMDES

This program will recommend the correct steel beam to use for a number of common applications. The user supplies the specifications of the load and spur. The distribution of the load and the manner in which the beam is fixed can be specified within limits.
Dataline.

BLOCK

BLOCK computes heating and cooling loads, sizes the air conditioning equipment and estimates the capacity of boiler and refrigeration plants. The program assists the user in selecting the proper insulation, glazing and shading devices, and lighting fixtures. By analyzing various alternatives, the program helps to determine the most suitable air conditioning system to meet the space requirements. The following systems are simulated by the program:
Heating and Ventilation System
Hot Water Radiation System
Air Systems
  Variable Volume, Constant Temperature
  Terminal Reheat
  Multizone
  Dual-Duct
Air Water Systems
  Induction Units
  Primary Air Fan Coil
HONEYWELL.

BRIDGE PIER ANALYSIS

The Bridge Pier Analysis (PIERANAL) program provides information on moments and shears in each member of a rigid frame structure when loads and a description of the structure are supplied as input.
Multiple Access Ltd. and CDC.

BUDGET STATUS SYSTEM

Comparisons of budgets vs costs for projects.
SWR.

BUILDING INDUSTRY PROGRAM (UNIBAU 91)

This program is used for calculations in the General Building Industry. It may also be used for superstructure, deep workings, road construction and dike construction. Besides computations of lengths, areas, and volumes.
UNIVAC.

BUILDING SUPPLIES CALCULATION

This package has been designed specifically for the construction industry to calculate the areas and volumes of materials used both in the excavation and the erection of structures of all types. The program uses formulas found in civil engineering handbooks to calculate areas such as rectangles, trapezoids, triangles, pentagons, circle segments, spirals, etc., and volumes such as cylinders, taurus, cones, etc.
UNIVAC.

CALCUL DES CONTRAINTES PRINCIPALES

Ce programme calcule les lectures réelles de déformation des témoins sonores. Il fait le calcul des déformations et, au moyen du cercle de MOHR, détermine la variation des déformations principales ainsi que la valeur des contraintes principales et leur direction.
SNC.

CBEES II (CANADIAN BUILDING ECONOMIC EVALUATION STUDY)

This program helps provide in-depth cash flow analysis and summary measures to help evaluate the economic viability of proposed building projects. CBEES II can be used on any type of building project and is designed to base its calculations on the new federal tax structure.
Portland Cement Association.

CIRCPLAT

CIRCPLAT performs an elastic bending analysis of circular plates.
CDC.

CIRCULAR CURVES

Output of this program is central angle, radius, chord, arc, tangent sector area and central angle, etc.
Wang.

CISC FLOOR SYSTEM SELECTION PROGRAM (FSSP)

The Floor System Selection Program is a tool designed to aid the structural engineer in determining the most economical steel floor system.
CISC and Multiple Access Ltd.

CIVCO

The CIVCO system is a problem-oriented computer language used by the engineer to solve large geometry problems. It is a tool to aid in the geometric calculations associated with the balancing of traverses, highway alignment, curved bridge geometry and subdivision layout.
CDC.

CIVIL ENGINEERING COORDINATE GEOMETRY (COGO)

Multiple Access.

COGO

A problem orientated computer language for solving geometric problems, developed to be simple and yet flexible in its approach to problem solving.

Dataline.

COGO-90

COGO-90 is a civil engineering problem oriented language that can be used in the solution of geometric problems. These problems arise in such fundamental areas of civil engineering as:

- Control, Land and Right of Way Surveys
- Highway and Interchange Design
- Construction Layout
- Bridge Geometry

Univac.

COLS

This program is intended to be a practical design aid for the selection of steel column sections in accordance with the requirements of CSA standard S16-1965. "Steel Structures for Buildings".

Dataline.

COLUMN LOAD ANALYSIS

Technical Programs Inc.

COLUMN SELECTION PROGRAM (2)

(based on CSA standard S16-1969)

This design aid is provided to assist engineers and architects to design steel structures by aiding their selection of suitable sections for steel columns.

Multiple Access and CISA and IBM and SNC.

COMPASS RULE BALANCE (UP TO 40 LEGS)

Wang.

COMPOSITE BEAM ANALYSIS

Designs the required beam section at span centreline using the Moment of Inertia method. Computes the location of both upper and lower flange plate cut-off points. Computes beam cambers, average stresses, and reactions for live load, dead load, and combinations of these in the web, flange, and beam ends.
Honeywell.

COMSPRING

COMSPRING performs the design and/or analysis of a straight, open-coil, round-wire, helical spring subjected to axial compressive loads.
CDC.

CONSTRUCTION COST ESTIMATING

Technical Programs, Inc.

CONSTRUCTION PROJECT CONTROL SYSTEM (CPC)

CPC provides a basic, flexible tool for bidding and managing construction projects, gaining the best possible utilization of labour and equipment resources under constantly changing conditions. The CPC System is made up of 28 programs that fall into four function categories: schedule generation, calendar generation, monitoring, and reporting.
Honeywell.

CONSTRUCTION SITE CUT AND FILL

Technical Programs, Inc.

CONTINUOUS BEAM ANALYSIS (BEAMANAL)

This program analyzes continuous beams on unyielding supports. Influence lines and maximum values of moments, shears and reactions are calculated automatically for girders subjected to the AASHO standard specification loading. BEAMANAL is particularly useful for the computation of influence lines for continuous beams and the analysis of highway bridge girders.
Multiple Access Ltd. and CDC.

CONTINUOUS GIRDER ANALYSIS

Produces the influence tables for a unit load at each span tenth-point, in up to five span continuous girders. Up to fifty changes in girder cross section are accepted. Cross section changes may be abrupt or linearly varying.
Honeywell.

CONTINUOUS SYSTEM MODELLING PROGRAM

Computel.

COOLING COIL SELECTION

Selection of water chilled cooling coils.
SWR.

COORDINATE GEOMETRY (COGO)

COGO is a problem-oriented programming system that enables civil engineers without computer experience to solve coordinate geometry problems. The prime feature of the system is that engineers state problems in familiar terminology such as azimuth, deflection, and traverse adjustment. COGO can be applied to the computation problems involved in control surveys, highway design, right-of-way surveys, interchange design, bridge geometry, subdivision work, land surveying, and construction.
SNC, I.P. Sharp

COORDINATE GEOMETRY

With this single program, it is possible to run a boundary closure with any or all of a set of options, each option selected by a single keystroke. Area may be accumulated if desired.

COORDINATE TRANSFORMATION

Given rotation angle, and coordinates of a point in both systems, transforms previously stored coordinates from one system to any other system.
Wang.

CORE

The program determines the internal moments and edge reaction induced by a uniform load on an L-shaped slab whose inner edge is supported by a continuous wall and whose outer edge is supported by columns.
Dataline.

CPM

CPM offers a systematic procedure which records, analyzes and controls each sequential step necessary for the completion of a particular work project.
CDC and Dataline.

CRITICAL PATH EVALUATION

This program will compute CPATH and print a summary of earliest and latest event times and actual and maximum activity times, and indicate which are on the critical path.
Hewlett Packard.

CRITICAL PATH SCHEDULING

DEC.

CRITSPEED

CRITSPEED performs a critical speeds analysis of rotating shafts.
CDC.

CROSS PRODUCT AND AREA

Cross product accumulates area computations for any of a set of options, if desired. When lot is closed, Area routine prints out total area in square feet and acres.
Wang.

CURVE DATA

Having arrived at the center point of a curve using any of a set of options, and given bearing out, calculates central angle, arc, chord and tangent, and traverses out the radial line.

CURVED BRIDGE GEOMETRY

Handles the 3-dimensional geometry of common bridge elements when the bridge lies partially or entirely on a simple curve. Both parallel and flared girders are accepted. Girders may be straight, curved, or broken. Up to four changes in pavement superelevation may occur within the scope of the problem.
Honeywell.

CUT AND FILL

Computes Cut and Fill Volumes
Wang.

CUT AND FILL CALCULATIONS

I.P. Sharp

DATA PRESENTATION SYSTEM

The 1130 Data Presentation System provides graphic programming support at three distinct levels of versatility and usefulness. The first level provides the programming necessary for control of the plotter. Level 2 subroutines utilize those of level 1 to perform more extensive tasks such as lines, plotting, scale annotation and curve fitting. The highest level, the Graphic Report Generator, provides the ability to make many different graphic presentations of data files without any programming effort by the user. It is controlled by input statements, which may be prepared by a person with no programming experience, that describe the plot to be generated and the data files to be processed.
IBM and SNC.

DATAPOINT

Datapoint is a two-axis, point-to-point programming language for preparing parts programs.
Datagen of Canada Ltd.

DEFORMATIONS PAR PENDULES

Ce programme calcule les mouvements du barrage et du rocher dans les directions X et Y à l'endroit de chaque pendule.
SNC.

DISTANCE - DISTANCE INTERSECT

Solves intersection and bearings of two lines whose lengths are known, given starting and ending coordinates, and the length of each line.
Wang.

DUCT SIZING

Calculation of air flow, duct sizes, cost estimates, etc. for a duct feeder system.
SWR.

DYNROSS

DYNROSS computes displacement and acceleration responses of a two-degree-of-freedom system. The response is given.
CDC.

EAC/EASE

EAC/EASE is an applications program designed to perform static structural analysis of linear, three-dimensional systems subjected to sets of arbitrarily prescribed mechanical and/or thermal loads and displacement boundary conditions. The results of the analysis include joint displacements and internal member forces or stresses at predetermined locations throughout the structure. Specific capabilities currently existing in the EASE package are listed below: Thermal loadings, Inertia Loadings, Normal Pressure Loadings, Concentrated and Distributed Beam Loadings, Concentrated Joint Loadings, Combined Loading Conditions, Displacement Boundary Conditions, Skew-Axis Boundary Conditions, Elastic Foundation Supports, Member-End Releases, Shear/Moment/Axial Force and Stress Tables, Plots of the Structural Model.
CDC.

EARTHWORK

Processes basic engineering design data and is not simply a "cut and fill" quantities calculator. Handles complete right of way design problems. Includes vertical curve and profile grade design, template design, off-shoulder design, including drainage channels, back-slope design, and multiple-layer terrain models. Provides special project capabilities: equations, lump sums, grade stations and end sections.
Honeywell.

EARTWORK

EARTWORK, a package modified from CUTFILL, provides massive calculations dealing with road building and its earthwork variables. The program calculates a profile, slope stakes, both ditches, medians, grades, rates for left and right offs, elevations, offs width elevations, rate of the offs elevations, areas, cubic yard quantities, summation quantities in cubic yards, cuts, and fills.
CDC.

ECAP

Electrical circuit analysis program
Computel.

ECONOMICAL DIMENSIONING OF A WATER SUPPLY TUNNEL

This program is intended for determining the economical type and section of a pressurized tunnel. Lined or unlined sections of any stage may be considered. The program includes a sub-program for the determination of the financial value of the headlosses based on energy cost and long term actualization. The program is intended for defining and sizing such a tunnel in the course of preliminary studies.
SNC.

ELASTCOL

ELASTCOL determines the smallest buckling load for elastic end-loaded columns. The column can have a variable moment of inertia and any stable combination of support conditions can be handled. A finite-difference technique is used to determine the buckling load and the associated mode shape.
CDC.

ELECTRICAL FEEDER

Sizing of electrical distribution system.
SWR.

ELEVATOR SELECTION

Selection of number, size and speed of elevators for vertical transportation of an office building.

SWR.

ENGEER

Engineering package.

DEC.

FACT

Financial data bank system for listed companies.

SWR.

FINANCIAL SIMULATION MODEL

Analysis of probable return on investment for high-rise building using monte carlo simulation.

SWR.

FLOOR SYSTEM SELECTION

Comparisons of various steel floor systems.

SWR.

FLOOR SYSTEM SUPPORTED BY CENTRAL CORE AND EXTERIOR COLUMNS

The program determines the internal moments and edge reactions induced by a uniform load on an L-shaped slab whose inner edge is supported by columns. The program enables the engineer to determine directly the moments for a particular slab and loading. The stiffnesses of the walls, columns, and the slab, and the spacing of columns can be made variables. The outer edge of the slab between columns can be made either restrained or unrestrained by the spandrel beam.

Portland Cement Association, UNIVAC and SDL.

FLPT

This program is designed to analyze and design a structure of flat plates and continuous concrete frames.

Dataline.

FRAME ANALYSIS
Technical Programs Inc.

FRAME CONSTANTS
Technical Programs Inc.

GASP II
Simulation of systems involving queuing problems
SWR.

GENERAL THERMAL PIPE STRESS AND DEFLECTION PROGRAM
This program computes the stresses and deflections arising in a 3-dimensional pipe network. It will cope with up to 30 branches, 15 branch points, and any number of loops and anchors. Provision is made to handle rigid stops, spring restraints, external forces, inflexible members, end point movements, and changes of pipe dimensions and properties within any branches of the network.
SDL and UNIVAC.

GENSECT1
GENSECT1 uses an integration technique to compute the section properties of arbitrary planar cross sections.
CDC.

GRIDMAP
GRIDMAP solves for the natural frequencies and the associated mode shapes of a rigidly jointed, two-dimensional, lumped-mass grid.
CDC.

GRIDSAP
GRIDSAP solves for the joint deflections and member forces of a rigidly jointed, two-dimensional grid.
CDC.

HAL (HORIZONTAL ALIGNMENT PROGRAM)

Calculation of horizontal curves for a length of roadway. The program has the following options which may be performed independently or simultaneously.

1. Calculation of various combinations of horizontal curves to fit the given horizontal tangents and the specified design criteria. (Refer to the program description for a list of possible design criteria).
2. Calculation of the coordinates for a series of points along the roadway.
3. Storage of the horizontal alignment data in a file where it may be retrieved for use at a later date.
4. Production of a scaled plot of the horizontal alignment. (Not operational).

ProConsul Limited.

HARDY-CROSS BALANCING OF A PIPE NETWORK

Wang.

THE HARDY CROSS METHOD

This program calculates the distribution of flow through a hydraulic network using the iterative method of Hardy Cross. It uses Hazen-Williams formula and accepts varying Hazen-Williams coefficients.

UNIVAC.

HEATING AND COOLING LOAD CALCULATION

Calculation of loads for a building of up to 700 rooms and 39 zones at up to 12 different times in a typical day of a month.

SWR.

HEATING - COOLING LOAD ESTIMATES

Calculation of approximate boiler, refrigeration and air handling unit sizes.

SWR.

HORIZONTAL GEOMETRY

Provides individual compute capabilities for all basic geometric problems in project layout and design. Handles compound and reverse curves, three centered curves, bull-nose curves, spirals and broken back curves.

HUBFLANG1

HUBFLANG1 performs the design and analysis of circular, bolted-flange connections for pressure vessels in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII.
CDC.

ICES BRIDGE (Bridge Design System)

The ICES BRIDGE I Design System is a design tool for bridge engineers. It is used as a decision-making aid in 1-the determination of bridge span arrangements, 2-concrete deck design, and 3-the preliminary design of simple or continuous span girders.
SDL.

ICES COGO I (COordinator GeOmetry)

The COGO subsystem of ICES may be used for describing and processing computational and design problems in the area of geometrics. Typical application areas include engineering surveys, highway design, right-of-way, construction layout, surveys and subdivisions.
SDL and Computel.

ICES LEASE-I (Limiting Equilibrium Analysis of Slopes and Embankments)

LEASE is a subsystem of ICES that is oriented toward the problem of evaluating the stability of slopes and embankments.
SDL.

ICES OPTECH I (Optimization Techniques System)

The OPTECH subsystem of ICES is designed to solve a variety of optimization problems which occur in engineering analysis and design and in the operation of engineering facilities. Application areas include multiple purpose water resource systems, network flow problems in the hydraulic and transportation fields, funding and scheduling problems in construction management and transportation facilities operation, and certain aspects of structural design.
SDL.

ICES PROJECT-I

PROJECT is a computer system created to assist in the planning and control of projects.
SDL.

ICES PROJECT/2

PROJECT/2 was designed to solve the scheduling control, cost and resource management aspects of projects within the framework of a network approach to the problem.

SDL. (MIT).

ICES ROADS-I (ROadway Analysis and Design System)

ROADS is used in the solution of problems involving the location and design of almost any type of roadway. Although intended for use primarily in connection with all classes of highways, the basic system framework and a majority of the computer routines are applicable to a wide range of civil engineering problems requiring the excavation and embankment of materials, including railroads, waterways, and dikes.

SDL and Computel.

ICES SEPOL I (SEttlement Problem Oriented Language)

ICES SEPOL-I is an ICES/360 subsystem for the calculation of stresses and strains in soil due to shallow foundation loadings, and the magnitudes and progress of settlement of shallow foundations. Thus, it may be used to perform settlement calculations for the design of buildings, earth dams, highway embankments, and other foundations which cause spread loadings at or near the surface of the soil.

SDL.

ICES STRUDL-II (STRUctural Design Language)

The STRUDL subsystem of ICES is a structural information system designed to assist the engineer throughout the design process. STRUDL can be applied to a wide range of structural types, both two-and three-dimensional structures consisting of truss, frame, and continuous finite elements.

SDL and Computel.

ICES TABLE-I and TABLE-II (ICES File Storage Subsystems)

ICES TABLE is a subsystem of ICES which may be used to create and manipulate tabular data. It is designed to provide great flexibility in the specification of data which may be used in conjunction with any ICES subsystem. TABLE creates disk files in designated data sets and provides other subsystems a programming function useful for transmitting tabulated information to its problem data base.
SDL.

ICES TRANSET I (Transportation Network Analysis)

The TRANSET Subsystem of ICES is designed to give the transportation planner a flexible and convenient method for predicting and analyzing the flows occurring in transportation networks. The TRANSET language is designed to analyze typical transportation networks representing highways or mass transportation facilities. However, the system can be applied to other types of networks, such as pipeline systems and electrical networks.
SDL and Computel.

ICES TRAVOL I (Traffic Volume Data Subsystem)

ICES TRAVOL is a subsystem for processing, storing, and applying traffic volume data for the purposes of transportation planning and research in an urban, regional or statewide context. It is designed to complement either continuing or short term programs of traffic counting where large quantities of data must be processed rapidly and efficiently.
SDL.

IDADS

Interactive disc-based drafting system
Varian Data Machines.

INDUSTRIAL PAYROLL SERVICE (IPS)

IPS provides an easy to use method of performing payroll functions.
Multiple Access Ltd.

INRING

INRING performs the structural analysis of thin, circular rings subject to loading in the plane of the ring.
CDC.

INTERSECTION DETECTION IN 3-DIMENSIONS

The Intersection Detection Program is a system that enables the user to:

1. Define 3 dimensional convex surfaces bounded by planes and quadric surfaces.
2. Define line segments in 3-space.
3. Test for intersections between pairs of objects.
4. Test for intersections between segments and objects.

The program is primarily a tool for the solution of pipe routing and component placement problems. The segment-object intersection test can also be used to solve the hidden line problem in computing graphic displays of 3-dimensional objects.

SDL.

INVERSE

Point to point inverse.

Wang.

INVERSE - HOLDING COORDINATES

Inverses from a fixed point to any other point, but retains coordinates of the fixed point.

Wang.

INVERSE TRIG

Calculates an angle in degrees, minutes and seconds when the Sin, Cos or Tan is known.

Wang.

KRAFT

KRAFT is a program which optimizes a given building floor plan according to numerically defined proximity criteria. The input is simplified to enable its use by architects, interior designers, and in a graphic form to closely resemble the conventional drawing format with which designers are familiar.

S. W. R. and Dataline.

LATERAL LOAD ANALYSIS OF MULTISTORY FRAMES WITH SHEAR WALLS

The purpose of this program is to analyze multistory frames with or without shear walls subjected to lateral loads. The engineer provides loads applied at each story and the program returns values for deflections, moments, shears and an equilibrium check of the structure.
Portland Cement Association, UNIVAC, SNC and SDL.

LEAST SQUARES ADJUSTMENT OF VERTICAL CONTROL NETWORKS

Establishment of elevations of stations which are connected, amongst themselves and to other stations of fixed elevation, by observations of elevation differences.
ProConsul Limited.

LESA (LEast Squares Adjustment and design of horizontal control networks)

Coordination of new stations in trilateration, traverse or triangulation control networks which may be independent of a coordinate system or within an existing network.
ProConsul Limited.

LIGHTING DESIGN

Room lighting calculation and fixture selection.
SWR.

LINEAR PROGRAMMING

Solution of linear equations.
SWR.

MARKET RESEARCH REPORTING SYSTEM

Tabulation of questionnaires.
SWR.

MATERIAL INVENTORY AND SCHEDULING SYSTEM

Varian Data Machines.

MEMBER FLEXIBILITY MATRIX

Calculation of flexibility matrix for a variable section member to be used as input to 'Stress' program.
SWR.

MINIPERT FOR PROJECT CONTROL

I.P. Sharp.

MLSTOANA

MLSTOANA is available for stress analysis of indeterminate structures such as multi-story rigid frame buildings.
CDC.

MODELS QUEUE SYSTEMS

Computel.

MRI/STARDYNE

The MRI/STARDYNE analysis system consists of a series of compatible digital computer programs designed to analyze linear elastic structural models. The system encompasses the full range of static and dynamic analysis. Three programs provide the analyst with a sophisticated, cost-effective, structural-dynamical analysis system.
CDC.

MSC/NASTRAN

Developed by NASA and modified by MacNeal-Schwendler Corporation (Los Angeles), MSC/NASTRAN provides solution of static and dynamic structural problems, elastic stability problems, and general matrix problems. Its application extends to virtually all structures.
CDC.

MULT

A program to analyze multistory frames with or without shear walls subjected to lateral loads.
Dataline.

MULTISPAN

MULTISPAN performs the bending analysis of multiple-span beams. The structure can have from one to 10 continuous spans having constant or variable cross sections. The interior supports are pinned, and the end supports can be fixed, pinned, or free.
CDC.

MULTI-STORY FRAME ANALYSIS

Technical Programs Inc.

NETWRK

This program provides an elementary method of solving the flow of water through a network of pipes, using the Hardy Cross method.
Dataline

NLHE INFORMATION SYSTEM

Generalized file maintenance and report generator.
SWR.

NON-PRISMATIC MOMENT DISTRIBUTION

Technical Programs Inc.

NUMERICAL SURFACE TECHNIQUES

Contour plotting and surface-to-surface volume calculations
SWR

OBLIQUE TRIANGLES

Calculates sides and angles of any triangle.
Wang

OFFSETS

Given two points to define a line, calculates station along the line and perpendicular offset distance to other points whose coordinates are known.
Wang.

OUTRING

OUTRING performs the structural analysis of thin, circular rings subjected to loading normal to the plane of the ring.
CDC.

PAYROLL SYSTEM

Employee payroll calculations and earnings file maintenance.
SWR.

PCABRIDGE

Analysis of bridge structures
Computel.

PCACOLUM

Analysis of columnar structures
Computel

PCAPLATPIN

Analysis of flat structures
Computel

PDMS (PROCONSUL DATA MANAGEMENT SYSTEM FOR GENERAL INFORMATION PROCESSING)

The principal functions of the system are: 1. Data Storage 2. Data Retrieval 3. Data Restructuring 4. Data Manipulation and Calculation 5. Report Generation
ProConsul Limited

PERT

Dataline.

PERT/COST

PERT is used to plan, monitor, and evaluate projects and programs; PERT/COST provides effective project control from the standpoint of cost. PERT/COST System utilizes a cost-oriented work breakdown structure to define the end items and functional sub-elements that are combined to produce the end items.
CDC.

PERT/TIME

PERT is used to plan, monitor and evaluate projects and programs; PERT/TIME provides effective project control from the standpoint of time. The PERT/TIME System utilizes a time-oriented network structure which represents the flow of work activities and events that mark their completion.
CDC.

PILE DRIVING ANALYSIS

The program calculates, for a given group of piles and hammers, the set in blows per inch to which the pile must be driven in order to obtain various values of ultimate resistance in kips. The stress in the pile corresponding to this resistance is also calculated.
SNC.

PIN JOINTED FRAMES

This program analyses and designs pin jointed frames. Geometry calculations are performed in order to keep input to a minimum. Load combinations for maximum and minimum stresses, deflections and plotter output are available.
SNC.

PIPEFLEX

This program uses tensor analysis methods to analyse the flexibility of multiple branch and closed-loop piping systems subject to thermal, uniform and concentrated loadings; it can also be applied to cryogenic piping systems.
CDC

PIPE-STRESS

The program computes the stresses and deflections arising in a pipe network as the result of thermal effects.
IBM / Private and SNC

PIPING DESIGN

Calculation of flow, pipe and pump sizes, heat loss/gain and cost estimate for a piping system.
SWR

PIPING FLEXIBILITY ANALYSIS PROGRAM

The purpose of this program is to consider the individual or combined thermal, pressure, weight and support reaction effects in a pipe systems and compute the final system reaction and stresses at anchors, support locations and all other data points.
Univac and SWR

PLOTPHASE (Plotting Phase Program)

Accepts output of calculation and text manipulating programs in the form of command-data files and writes a file (tape) to produce a specific graphic presentation (with scale factors, rotation, page size, etc.), defined by the user.
Pro Consul Limited

PLOTTER

By connecting an incremental plotter to a computer the user has at his command a drafting machine of sufficient sophistication to produce any kind of graphic output whilst the computer assumes the order of detailed control.
Dataline

POST-TENSIONED CONTINUOUS BEAM DESIGN

Technical Programs, Inc.

PRELIMINARY DAM DESIGN

This program designs the most economical arch dam with respect to volume and stresses.
SNC

PROFILE

Calculates stations and elevations along a straight grade or along a vertical curve.
Wang

PROJECT CONTROL SYSTEM

Scheduling and progress reporting on a project described by a critical path network.
SWR.

PROJECT COSTING/BILLING SYSTEM

Project invoices, billings and billing status. Sub-system of budget status system.
SWR.

PROJECT COSTING SYSTEM (PROCOST)

Multiple Access General Computer Corporation's Project Costing System (PROCOST) is a set of fully supported computer programs to aid engineers, contractors, and architects to control the progress and cost of projects. This system may also be applied to other types of projects in which the allocation and control of employee time and cost is essential.
Multiple Access Ltd.

PROJECT MANAGEMENT AND CONTROL SYSTEM (PMCS)

PMCS is a modern Critical Path system. This powerful, but simple, technique is used for planning, scheduling and controlling large complex projects. It identifies both current and potential problem areas of the project so that corrective action may be applied immediately.
Multiple Access Ltd.

PROJECT MANAGEMENT SYSTEM (PMS)

PMS/360 is a system of computer programs to aid in the project management functions of critical path analysis, resource allocation, project costs and progress control and report generations.
SDL and Computel

PROJECT PLANNING SYSTEM

PPSIV is the fourth improved revision of computer program which aids in planning and managing complex projects such as construction jobs and maintenance of refineries, chemical plants and airplanes. It is a fast critical-path method/resource allocation program designed to find the shortest feasible project length while observing restrictions on manpower and equipment. PPS IV produces work schedules that enable the user to shorten project length, whether it is plant turnaround or a long-term construction project, and also help the user utilize each resource fully, men and equipment.
CDC.

QUANT (QUANTITIES PROGRAM)
Calculation of Earth and Material quantities.
ProConsul Limited.

QUICKIE BEAM ANALYSIS (with Beam Analysis)
Technical Programs Inc.

R/C RETAINING WALL DESIGN
Design of cantilever retaining walls bearing on soil.
SWR.

RECTANGULAR CONCRETE BEAM DESIGN
Technical Programs, Inc.

RECTANGULAR CONCRETE COLUMN DESIGN
Technical Programs, Inc.

REINFORCED CONCRETE BEAM DESIGN
Selection of beam member size and calculation of reinforcing requirements by ultimate strength method.
SWR.

REINFORCED CONCRETE COLUMN DESIGN
Reinforcement selection by ultimate strength methods for a column section subjected to axial load and biaxial bending.
SWR.

REINFORCED CONCRETE FLAT PLATE OR SLAB DESIGN
Analysis of specified slab by the elastic method and calculation of reinforcing requirements including bar selection.
SWR.

REINFORCED CONCRETE FLAT SLAB DESIGN
Selection of slab thickness and calculation of reinforced requirements by empirical method.
SWR.

REINFORCED CONCRETE RECTANGULAR FOOTING DESIGN

Design of combined rectangular footing bearing on soil.
SWR.

REINFORCED CONCRETE SQUARE FOOTING DESIGN

Design of axially loaded square footing bearing on soil.
SWR.

REINFORCEMENT OF HOLES IN STEEL BEAMS

Reinforces rectangular holes with plates on 4 sides of opening.
SWR.

REINFORCING STEEL BAR-LISTING

This program was developed to assist the reinforcing detailer to prepare bar lists. The final product is a bar list ready for client.
SNC

RETAINING WALL DESIGN

Technical Programs, Inc.

RETAINING WALL DESIGN AND ANALYSIS

Program will design cantilevered retaining walls within prescribed limits. Optimum design is based on gross size of wall. Amount of steel is also included in the design. Analysis for safety against rupture, sliding, and overturn is obtained for either cantilever or gravity retaining walls.
Honeywell.

RIGHT TRIANGLES

Calculates the third side of a right triangle, given any 2 sides.
Wang

RIGID FRAME SELECTION PROGRAM (RFSP/360)

This program performs computations on data representing structure geometry, loads, member shapes, structure behaviour and materials. From a user's inventory and materials specification, RFSP selects the most economical members of that inventory to use. It operates in a highly modular fashion to find least-weight designs for members of different types of structures. RFSP design procedures apply to 2- and 3-hinged frames in steel, reinforced concrete or laminated wood.

SDL

ROARK STRESS AND STRAIN FORMULA

I.P. Sharp

SAMPL

SAMPL provides an easy-to-use method for describing and analyzing problems involving uncertainty. It can be used for time-dependent or time-independent problems, with or without uncertainty in the data. SAMPL includes built-in routines for the calculation of rate of return, present value, year of payout, and sum overtime periods.

SDL

SEAL-SHELL-2

SHELL is a computer program for the stress analysis of a thin or thick shell of revolution with axisymmetric pressures, temperatures, and distributed loader. Some applications are pressure vessel and nozzle design, bellow and seal weld stress analysis, stress analysis of bellmouthing of pipes including non-uniform distribution of thread loads and thermal stresses in any of the preceding.

UNIVAC

SECTION PROPERTIES

Technical Programs, Inc.

SHOCSPEC

SHOCSPEC computes the shock and Fourier spectrum for a base-excited, viscous-damped, single-degree-of-freedom system. A digital filter computation technique is used to compute the spectrum for any one of four response parameters: the Fourier variable, relative displacement, relative velocity, or absolute acceleration.
CDC.

SIDE SHOTS

Allows side shot coordinates to be calculated, using as control points any point previously stored with the option of entering a control point from the keyboard.
Wang.

SIMPLE SPAN PRESTRESSED BEAM DESIGN #1

Technical Programs, Inc.

SIMPLE SPAN PRESTRESSED BEAM DESIGN #2

Technical Programs, Inc.

SINSPONS

SINSPONS computes displacement and acceleration responses of multi-degree-of-freedom systems subjected to harmonic loads of harmonic base excitations.
CDC.

SLOPE STABILITY ANALYSIS

Uses the Swedish Slip-Circle method of analysis. Determines, through an iterative method, the location of the critical failure circle. This represents the minimum safety factor for the slope. The water table may be anywhere in the embankment.
Honeywell.

SOIL STABILITY

This program is designed to assist civil engineers in analyzing earthen structures. The program computes the minimum safety factor against sliding for earth embankments, using the Swedish Slip Circle method of slices.
CDC.

SPECIFICATION PRINTING
Retrieval and modification of master specification to produce a custom job specification.
SWR.

STADIA REDUCTION
Calculates elevation and horizontal distance from observer to a point, given stadia data.
Wang

STAGGERED WALL-BEAM FRAMES
The program is intended specifically for the analysis and design of a staggered wall-beam building.
Portland Cement Association and SDL

STAK
To calculate the stake-out distance and turn-angles of all given construction points from established co-ordinated "Base-Stations".
ProConsul Ltd.

STANBEAM
STANBEAM performs the bending analysis of single-span beams. The beam can have a variable cross section, and any stable combination of support conditions can be handled. Internal forces and displacements are found using an integration procedure. Maximum shear and bending stresses are calculated by the usual VQ/IB and MC/I formulas.
CDC.

STANSECT
STANSECT computes the section properties of 18 types of standard cross sections (i.e. I's, Z's, T's and others).
CDC.

STATISTICAL ANALYSIS SYSTEM
Data analysis by advanced statistical techniques.
SWR.

STEEL BASE PLATE DESIGN
Technical Programs, Inc.

STEEL BEAM DESIGN

Selection of 'least-cost' catalogue steel beam shape meeting specified limits and carrying applied loads without distress.
SWR.

STEEL BEAM DESIGN

Technical Programs, Inc.

STEEL COLUMN DESIGN

Selection of catalogue steel column shape for specified loads, moments, stiffness factors and unsupported heights. Based on CISC Program.
SWR.

STEEL COLUMN DESIGN

Technical Programs, Inc.

STEEL-DESIGN (STEED)

STEED is a steel selection program and is applicable to industrial type structural steel buildings. It can handle multi-story buildings and designs floor beams and columns. Reactions and column loads are automatically carried from one member to the other.
SNC.

STEEL TRUSS DESIGN

Technical Programs, Inc.

STIFSHEL

STIFSHEL treats the elastic stability problem of a cylindrical shell under a hydrostatic external pressure.
CDC.

STOF

To calculate for each given construction point the station, offset and elevation values and to insert the description codes.
ProConsul Ltd.

STRESS

STRESS is a problem oriented input language that enables the engineer to write a complete input program for the solution of its structural problem. A knowledge of programming is not necessary. The principal virtue of the system is that it can handle a wide variety of structural analyses with minimum of programming effort. STRESS can analyze structures in two or three dimensions with either pinned or rigid joints with prismatic or non-prismatic members and subjected to concentrated or distributed loads, support motions or temperature effects.
CDC, MIT, UNIVAC, IBM, SNC, SWR, and Dataline.

STRESS-PLOT

STRESS-PLOT is a program that plots the geometry of plane frames and plane trusses from the STRESS input cards.
Bethlehem Steel Corp., SNC and SWR.

STRUCTURAL DESIGN LANGUAGE (STRUDL)

STRUDL is a subsystem of ICES (Integrated Civil Engineering System) and is applicable to a wide range of structural problems. It will treat framed structures in two or three dimensions with rigid or pinned joints or a combination thereof. Members may be non-prismatic and have any orientation with respect to the frame. Loadings may be concentrated or distributed and may be forces, moments or imposed distortions (e.g. temperature changes or support settlements). Loading conditions may also be combined in any manner. Available analytical methods are a force equilibrium analysis for determinate structures, an indeterminate stiffness analysis, and an approximate analysis procedure based on user-specified assumptions.
MIT and SNC.

STRUCTURAL ENGINEERING SYSTEM SOLVER (STRESS 3.0)

STRESS 3.0 is a program useful in obtaining a fast and accurate analysis of two and three dimensional framed structures.
Multiple Access Ltd.

STRUDL-II - CSA-S16

A steel design module based on CSA S16-1969 and Canadian steel sections has been added to STRUDL II for member selections or member checking in two or three dimensional trusses and frames. SDL and service bureaus with IBM S/360 hardware, available at most datacentres.

SURGE TANK ANALYSIS

This program may be used:

- for sizing the surge tank in the course of preliminary studies
- for detail analysis of the mass oscillations in the system and simulation of generating unit operation.

The program allows for analysis of cylindral and throttled surge tanks as well as for surge shafts with expansion chambers and any combination of those.

SURVEY

"SURVEY" is a problem-oriented language designed for survey calculations and subdivision analysis. This language permits the land surveyor (who may be unfamiliar with computers) to solve simple or complex problems in familiar terminology at a remote terminal.
Multiple Access Ltd.

SURVEY

Computation of bearings, distances, areas and co-ordinates of any geometric configuration composed of straight or curved lines.
ProConsul Limited

SYMPL

SYMPL was designed to assist in preparing projections of the future, i.e. forecasting, planning, budgeting, etc. Provision is made for the user to create a data bank of time dependent data, to manipulate the data, and to generate reports using specific parts of the data.
SDL.

TEE-BEAM DESIGN
Technical Programs, Inc.

TEMPERATURE GRADIENT
The program calculates the temperature gradient resulting from linear heat flow within a homogeneous solid bounded by 2 parallel surfaces.
SNC.

TESTRAIN
TESTRAIN calculates principal stresses and strains for a set of user-defined strain gage readings.
CDC.

TEXT/360
TEXT/360 is a text-processing system with data-entry, data-updating, and page-formatting capabilities.
SDL.

THREE POINT PROBLEM
Solves the coordinates of a point, given coordinates of three observation points and the two included angles.
Wang.

TOPO REDUCTION
Calculates elevations for topographic work.
Wang.

TORECELL
TORECELL performs a torsional analysis of thin-walled multicellular, closed sections.
CDC.

TRANFLOW
Transportation model using flowgraph method.
SRW.

TRANSFORMATION DES LECTURES DE DEFORMATION ET DE TEMPERATURE OBTENUES A L'AIDE DE TEMOINS SONORES

Ce programme fait la transformation des lectures brutes de déformation et de température prises sur les témoins sonores placés dans la masse de béton d'un barrage, en lectures réelles (déformations en 2 fois microns par mètre et températures en degrés centigrades). Ces lectures serviront à la mise en graphique et au calcul des contraintes principales.
SNC.

TRANSPORTATION MODEL

Solution of supply and demand problems at lowest cost.
SWR.

TRAVERSE

Dec.

TRAVERSE

Given azimuth or bearing, and distance, traverses point to point.
Wang.

TRAVERSE ANALYSIS

Solves all basic problems in traverse analysis, including the solution for one or two unknown components of the traverse. Accepts bearing, angular-deflection, or included angle input for course heading data.
Honeywell.

TRAVERSE CLOSURE (UP TO 40 LEGS)

Wang.

TRAVERSE CLOSURE FROM FIELD DATA

Calculates coordinates, for any number of legs, using field angles or azimuths, and distances. Up to 40 legs are retained in memory for automatic balancing with no data re-entry. Relative and absolute errors are calculated.
Wang.

TRIG FUNCTIONS

Computes Sin, Cos, Tan for angles given in degrees, minutes and seconds.
Wang.

TRUSS ANALYSIS

Technical Programs Inc.

TWO WAY SLAB DESIGN

Ultimate strength design of a two-way slab supported on beams, moments by empirical method.
SWR.

ULTIMATE STRENGTH DESIGN OF REINFORCED CONCRETE COLUMNS

The purpose of this program is to give engineers the capability to design reinforced concrete columns to resist a given combination of loadings or to investigate the adequacy. Each loading case consists of an axial compressive force combined with uniaxial or biaxial bending. The method of solution is based on accepted ultimate strength theories for reinforced concrete design and, where applicable, assumptions and limits conform to the ACI Building Code (ACI 318-63).
SNC, PCA, SDL and Dataline, UNIVAC.

ULTIMATE STRENGTH OF PRESTRESSED BEAMS

Technical Programs, Inc.

UNIVAC CO-ORDINATE GEOMETRY SYSTEM (UNICOG)

UNICOG is used in civil engineering for computations associated with surveying and subdivision design. Solutions are provided for traverse, inverse, circular curves, areas, and intersections problems.
UNIVAC.

VAL (VERTICAL ALIGNMENT PROGRAM)

Calculation of vertical parabolic curves for a length of roadway.
ProConsul Limited.

VEHICULAR TRAFFIC CONTROL TRAFFIC SIGNAL OPTIMAL PROGRESSION PROGRAM (TSOP/360)

This program designs traffic signal progressions with maximum average vehicle speeds and minimum signal cycle time with given restrictions, such as speed limits and required traffic volumes. A least-squares fit model is used to develop a space periodicity constant.
SDL.

WATER DISTRIBUTION SYSTEM ANALYSIS

This program is designed to assist sanitary engineers in analyzing a water distribution system consisting of a network of pipes. The program calculates the headloss coefficient (k), flow, and the headloss in each pipe of the network. The Hardy Cross relaxation method is used in the analysis.
CDC.

WATER NETWORK ANALYSIS

Using the Hardy-Cross method, the program computes balances flows and headlosses in a water pipe network.
SNC.

WATERHAMMER

This program is intended for the analysis of the pressure and velocity fluctuations throughout a pipe network under transient conditions following operation of a valve or turbine control gate.
SNC.

WEIGHTED COMPASS RULE BALANCE

Balances, by compass rule, all legs stored in Traverse Closure program and prints adjusted bearings, distances, latitudes, departures and coordinates. Each leg may be held or assigned a factor to weight the balance of that leg compared to other legs and calculates, in acres and square feet, the area enclosed.
Wang.

WIND LOADS ON TALL STRUCTURES

Technical Programs Inc.

2DFMAP

2DFMAP solves for the natural frequencies and the associated mode shapes of a rigidly jointed, two-dimensional, lumped-mass frame.
CDC.

2DFSAP

2DFSAP solves for the joint deflections and member forces of a rigidly jointed, two-dimensional frame.
CDC.

2DGENFRAME

2DGENFRAME performs the bending analysis of two-dimensional frames. Frame members can be rigidly attached or pin connected.
CDC.

2DTMAP

2DTMAP solves for the natural frequencies and the associated mode shapes of a pin-jointed, two-dimensional, lumped-mass truss.
CDC.

2DTSAP

2DTSAP solves for the joint deflections and member forces of a pin-jointed, two-dimensional truss.
CDC.

3DFMAP

3DFMAP solves for the natural frequencies and the associated mode shapes of a rigidly jointed, three dimentional lumped-mass frame.
CDC.

3DFSAP

3DFSAP solves for the joint deflections and member forces of a rigidly jointed, three-dimensional frame.
CDC.

3DTMAP

3DTMAP solves for the natural frequencies and the associated mode shapes of a pin-jointed, three dimensional, lumped-mass truss.
CDC.

3DTSAP

3DTSAP solves for the joint deflections and member forces of a pin-jointed, three-dimensional truss.

CDC.

SOURCES

Alphatext Systems Ltd.
233 Gilmour St.
Ottawa, Canada

CDC (Control Data Corp.)
50 Hallcrown Place
Willowdale, Ontario

CISC (Canadian Institute of Steel Construction)
1815 Yonge St.
Toronto, Ontario

Computel Systems Ltd.
Place du Canada
Montreal 101, P.Q.

Data General Corporation
Southboro, Mass. 01772
USA

Datagen of Canada Ltd.
Richelieu Park
Hull, P.Q.

Dataline
40 St. Clair W.
Toronto, Ontario

Digital Equipment of Canada Ltd.
150 Rosamond St.
Carleton Place, Ontario

Hewlett Packard (Canada) Ltd.
50 Galaxy Blvd.
Rexdale, Ontario

Honeywell Information Systems
Heron's Hill, 2025 Sheppard Ave. E.
Willowdale, Ontario

IBM Canada Ltd.
1150 Eglinton Ave. E.
Don Mills 402, Ontario

Multiple Access Ltd.
885 Don Mills Rd.
Don Mills 403, Ontario

ProConsul Limited
74 Victoria St.
Toronto 1, Ontario

SCL (Systems Corporation Ltd.)
16700 Transcanada Highway
Kirkland - Roxboro 950, P.Q.

SDL (Systems Dimensions Ltd.)
770 Brookfield Rd.
Ottawa, Ontario

SNC (Surveyer, Nenniger & Chenevert, Inc.)
1550 de Maisonneuve W.
Montreal 107, P.Q.

SWR (Searle, Wilbee, Rowland)
1400 Don Mills Rd.
Don Mills, Ontario

I.P. Sharp Associates Ltd.
P.O. Box 71
Toronto Dominion Centre
Toronto 1, Ontario

Technical Programs, Inc.
604 Park Drive
University Park
Boca Raton, Fla. 33432

Univac Division
55 City Centre Drive
Missisauga, Ontario

Varian Associates of Canada Ltd.
63 Bedford, Box 1347
Place Bonaventure
Montreal 114, P.Q.

Wang Laboratories (Canada) Ltd.
3333 Cavendish Blvd.
Montreal 28, P.Q.

INDUSTRY CANADA/INDUSTRIE CANADA

63196