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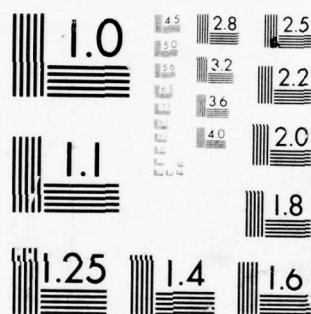
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PROCEEDINGS OF THE  
CIB W-65 WORKING COMMISSION  
ON ORGANIZATION AND MANAGEMENT  
OF CONSTRUCTION

VOLUME III:

INTERNATIONAL COUNCIL FOR BUILDING RESEARCH  
AND DOCUMENTATION AND DISSEMINATION

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report presents the proceedings of the Symposium on the Organization and Management of Construction presented by the Working Commission of the International Council for Building Research and Documentation and Dissemination at Edinburgh, Scotland in September 1977. This volume contains rapporteur papers on the topics of organization and management of construction of the firm, the technology transfer of organization and management of construction, and a morphology of the construction industry.		

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# PREFACE

The Working Commission W-65, Organization and Management of Construction of the International Council for Building Research and Documentation and Dissemination held a meeting in Edinburgh, Scotland on 11 September 1977. The Commission meeting consists, in part, of reporting of technical programs sponsored by the Commission. One of these technical programs is "Rapporteur-by-Correspondence"; subject areas in this program are:

- a. OMC in Developing Countries: Rapporteur - Dr. M. Pavlidou (Greece).
- b. OMC of the Firm: Rapporteur - Dr. W. Diepeveen (Netherlands).
- c. OMC in Large Projects: Rapporteur - Dr. J. Denes (Hungary).
- d. Technology Transfer of OMC: Rapporteurs - MAJ T. Ryan (USA) and Mr. J. Parssons (Sweden).
- e. OMC in Design and Architecture: Rapporteur - Professor Frew (USA).
- f. OMC - Education and Training: Rapporteur - Professor V. Handa (Canada).

Reporting in this program consists both of the rapporteur paper and the individual contributions submitted by researchers. In the Edinburgh meeting, however, only rapporteur papers were presented in the following topics: (1) OMC in Developing Countries; (2) OMC of the Firm; and (3) Technology Transfer of OMC. This publication includes the papers in topics (2) and (3); the paper in topic (1) is given in the Proceedings of the CIB Congress held in Edinburgh from 12 - 21 September 1977.

Another technical program of the Commission is Cooperative Research in OMC with the principals being Professors R. Pilcher and B. Whiteside of England and T. Bolland of Ireland. The subject of this cooperative research is the morphological study of the construction industry. The paper presented to the Commission was prepared by T. Bolland and is given herein; he also made a contribution to the CIB Congress.

Additional copies of this publication can be obtained from the National Technical Information Service, P. O. Box 1553, Springfield, VA 22151, USA. A limited number of additional copies will also be available from Secretary General J. R. Janssens, Postbuss 20704, Weena 704, Rotterdam, HOLLAND. The Secretary General can provide information on the Proceedings of the CIB Congress.

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ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

by

W. J. Diepeveen

C.I.B. W.65  
ORGANIZATION AND MANAGEMENT OF CONSTRUCTION

-----  
Dr. W.J. Diepeveen

The management of the construction firm  
-----

The management of the construction firm is responsible for setting the aims of the firm, for its strategy, for working out the policy, based on the aims and the strategy and finally for drawing up the operational plans for the firm on the basis of the policy of the firm.

The manager should anticipate the developments of the market, which his firm has chosen. He has to adapt his management according to continuous changes in the circumstances of the environment. Therefore he has to make use of the modern methods of management, of co-operation, marketing and organization to run his business.

His tasks can be visualized in a diagram, which concentrates on two activities: formulating the firm's policy for the future and drawing up the planning to carry out this policy. In the diagram the left hand side illustrates the external and internal influences on the policy of the firm. The right hand side of the diagram illustrates the plans that will be used to realize the strategy of the firm in making its policy operational.

Aims and strategy

The plans in a construction firm are primarily based on a study of the future developments in the construction industry. These factors are of economic, technical, social and political character. They have a general influence on the construction industry, e.g. price developments, technical improvements, quality demands etc. This macro-information has to be studied and analyzed by the management of the firm. Each firm will come to different conclusions in its choice of the products it will specialize in (product assortment) and the techniques to be used.

Then a firm should consider its competitive position with regard to other firms on the aspects of quality, price, relations etc. On the basis of the general information and the knowledge of the competitive



strength of the firm the management will decide on the development of the future turnover of the firm per product and per market sector (product/market-combination).

Topmanagement should as well study the strengths and weaknesses of the internal organization of the firm in order to decide upon its future aims and the strategy to be followed to realize them. The strength of the management on all levels of the firm will be decisive for the possibilities of the firm on the market.

No plans can be developed if the financial capacity to realize the plans is not available. In this field rentability and profitability are essential factors to be considered by the firm's management.

The result of all these activities is the formulation of the future aims of the firm and the strategy that management will use to realize its plans.

#### Planning

The topmanagement of the firm is thereafter responsible to build up an operational planning system for the different activities in the firm. This has been illustrated in the right hand part of the diagram.

To begin with the planning will indicate all decisions that are necessary on short notice. Some activities have priority, because they cannot wait, e.g. buying a tower crane for a project the firm has offered to construct and that will start immediately.

Also plans will have to be made for the marketing operations of the firm in the next few years. Then topmanagement will look after drawing up plans for the development of products, the development of the organization of the firm, staff policy and the financial planning, that is necessary for the development of all the plans that are to be made for the next few years. All these activities are parts of a continuous process, that can only be set up with fantasy and on the basis of exact information (figures and facts). This work can be delegated to staff members, such as corporate planners, but topmanagement should be responsible for directing these activities.



### List of planning activities

#### Market development -----

Planning for this subject should pay attention to

- product/market-combination
- market research
- instruments for market development
  - . quality
  - . assortment
  - . service
  - . pricing
  - . selling channels
  - . relations
  - . acquisition
- marketing plan
- costs of marketing
- organization of marketing
- feedback
- international marketing

#### Organization of the firm -----

Planning should pay attention to

- organization development
- team work
- job discussions
- techniques for organization development (training and management systems)
- rôle of topmanagement
- job enrichment and job enlargement
- problem solving techniques
- expansion, stabilization or regression
- democracy in decisions

#### **Product development plans**

-----

**Planning should pay attention to**

- product management
- rationalization in the production
  - . specialization
  - . co-ordination
  - . standardization
  - . mechanization
  - . concentration
- production methods and building costs
  - . traditional
  - . industrialized
- building product and quality
- building capacity
- product research
- product innovation and creativity
- productivity problems
- project leaders and product managers
- building process problems and the management of the firm
  - . construction oriented management
  - . business oriented management
- training

#### **Staff planning**

-----

- selection of staff
- education
- motivation
- salary-structure
- communication
- career planning and staff review

### Financial planning

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- rentability
- profitability
- investment problems
- costing
- budgeting
- liquidity and solvability
- investment programming

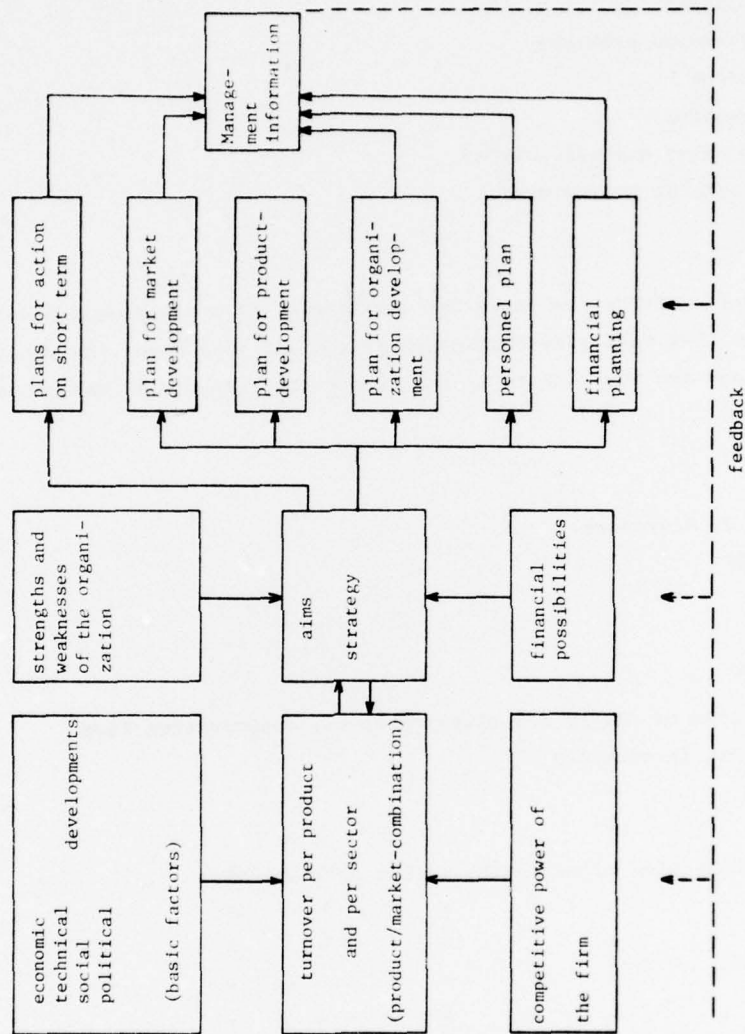
A final activity should be the development of a management information system that will give topmanagement a clear idea about the progress of plans and the results in the firm on all aspects of the planning.

Dr. W.J. Diepeveen.

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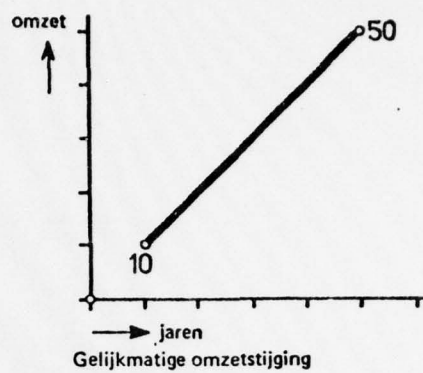
### Annexes.

1. Diagram of policy and planning in the construction firm
2. Growth in turnover
3. " " "
4. " " "
5. Organization of marketing in the building firm
6. " " " " " " "
7. " " " " " " "
8. " " " " " " "
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10. Matrix structure in a building firm
11. Relations between different teams
12. Projectmanagement in a matrix structure in a firm
13. Projectleader and productmanager in a building firm

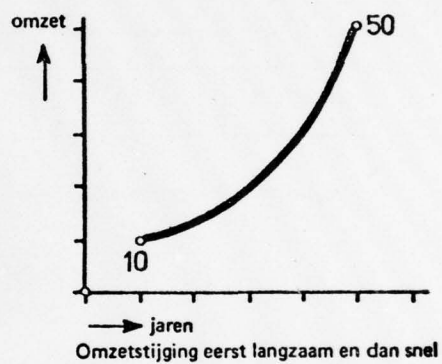


Model for policy and planning in the construction firm

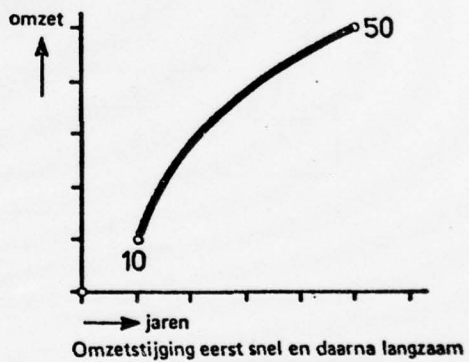
Figuur 15



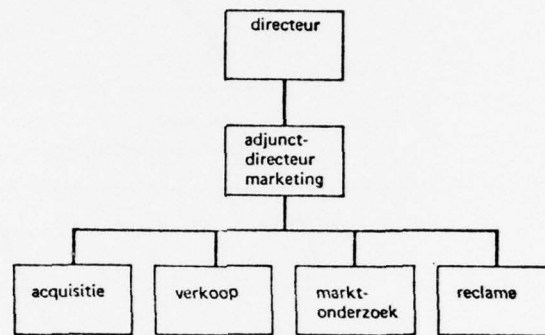
Figuur 16



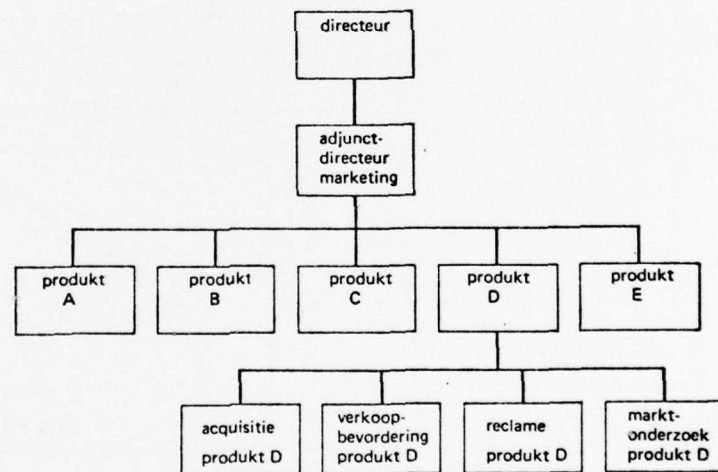
Figuur 17



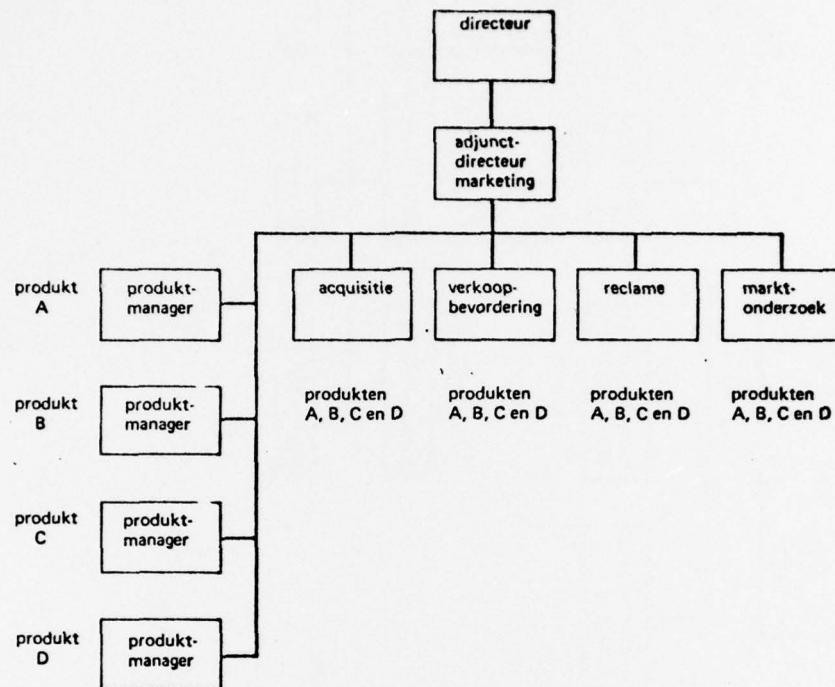




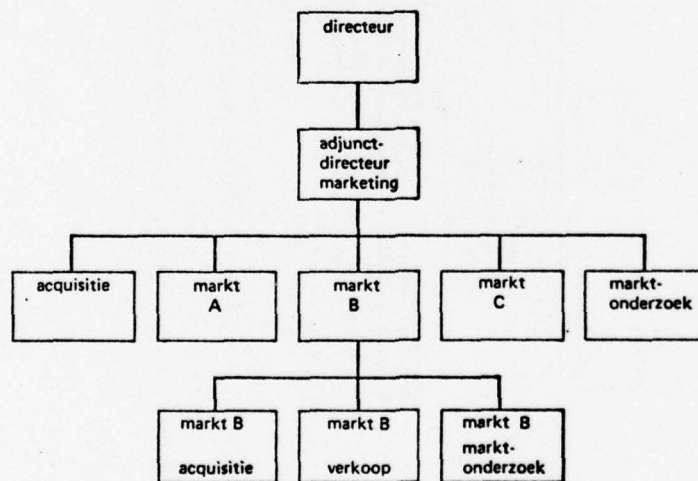
*Figuur 46 Marketingstructuur, gericht op de functies in de marketing.*



*Figuur 47 Marketingstructuur, gericht op produkten.*



Figuur 48 Marketingstructuur met produktmanagers.



Figuur 49 Marketingstructuur gericht op markten of relaties.

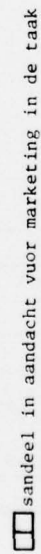
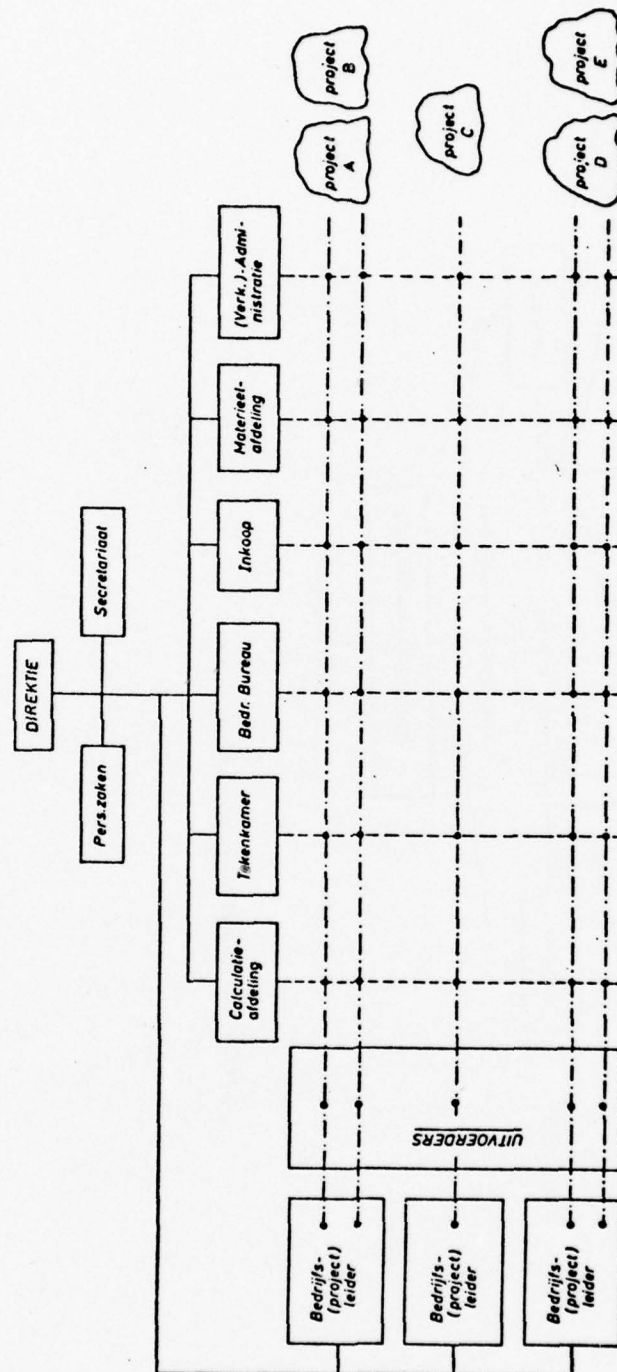


Figure 50 Marketing-aspecten in de taak van verschillende functionarissen.



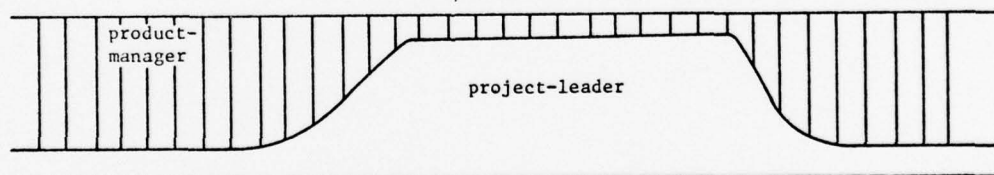
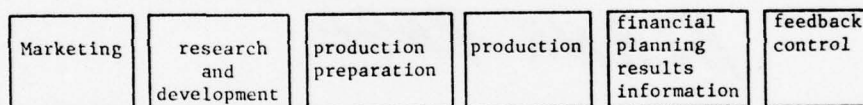
Figuur 11. Voorbeeld van een matrixstructuur in een bouwonderneming.





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Project Coordinator										
Project Coordinator										
Project Coordinator										
Project Coordinator										
		Behandeling door projectteams								

Figuur 31. Projectbehandeling bij een matrix-organisatievorm.



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ORGANISATION AND CONTROL SYSTEMS IN BUILDING COMPANIES

by

Peter Docherty, Sten Penhoff and Jan Pärsson

Paper to the CIB Conference, Edinburgh, 1977

ORGANISATION AND CONTROL SYSTEMS IN BUILDING COMPANIES - An Action Learning  
Approach to Organizational Development. \*

Peter Docherty, Sten Penhoff and Jan Pärsson  
Research Paper 6096 September 1977

Background.

Changes in the environment.

This project has its origin in the growing awareness in many building companies that developments in certain central features of their organisation and administration during the last 10-15 years have not been sufficiently aligned to the many vital and far-reaching changes in their environment and that a radical change in their development strategy in these areas is necessary if the new environmental demands are to be accommodated.

What major environmental changes have occurred during the last ten years? An extended boom in the building industry in the postwar period topped by intensive house building programs in the "Golden sixties" was replaced by a serious slump in the early seventies. The general expectation that this was simply an extraordinarily severe dip in the normal economic cycle has proved to be groundless. The current interpretation of the situation is that the major part of the drop in the market is basically permanent, i.e. the size of the building market is and will be much smaller than in the preceding postwar period. The industry has experienced a number of marked swings in the economic cycle during the seventies, (although around a lower mean than in the preceding postwar period). At the same time the demands on the market changed. Home building in the sixties was primarily concentrated on high-rise apartment buildings whereas the current demand is mainly for bungalows, detached and terraced houses.

There have also been a number of important changes in the labour market. A number of factors such as the fall in the market, the high demand for skilled workers in industries offering better security and better working environments led to a marked drain of qualified workers from the building

\* This project is financed by the Swedish Building Research Fund.

industry in the late sixties. The majority of these have never returned. At the same time there has been a general disenchantment among schoolleavers towards working in industry so that the loss in old blood has not been replaced by new. Many firms today feel that they have insufficient qualified labour to handle their current orders and that immediate steps are required to increase the numbers, skills and involvement of building workers.

The last six or seven years have also witnessed extensive legislation applying to the labour market. The government has set aside its traditional policy of nonintervention in the labour market and has recently introduced a number of laws regarding job security, job safety and working environment and the rights and responsibilities of union representatives at the workplace. But the legislation which has been regarded as most general and important in its impacts is the new legislation on co-determination. This provides the unions with the opportunity of demanding negotiations and drawing up joint agreements on most aspects of the company's activities. In several instances, such as the engagement of subcontractors and consultants, the union has the right of veto in company decisions. The new legislation necessitates significant adjustments in the decision and control processes in building companies.

#### Planning philosophy

A central element of the management of a company is the planning function covering such aspects as its underlying planning philosophy as well as organisation of the available planning resources. Figure 1 for example illustrates two clearly distinguishable attitudes to planning.

In the first, the alpha perspective, the aim of planning is to arrive at the best way of working to achieve optimal resource utilization and to provide instruments to control and co-ordinate activities. Experts who have acquired special knowledge and experience and have mastered certain techniques produce plans which prescribe the activities of those who will carry out the activities covered by the plans. Such plans constitute a detailed programming of activities which are broken down into small steps. The allocation of the resources to the separate steps and their ordering in time are regarded as the key tasks. The manning of these activities and the design of a suitable work organisation for the execution of the plan are regarded



PLANNING PERSPECTIVE	ALPHA	DELTA
WHY PLAN?	To arrive at the 'best' way of working to achieve optimal resource utilization  PLANS ARE PRESCRIPTIVE	To arrive at an understanding of problems and to establish knowledge skills and resource can be necessary  PLANS CONSTITUTE A SUPPORTIVE BASIS FOR WORK
WHO PLANS?	WE (who can)	WE (who will carry out the work)
FOR WHOM?	THEM (who will carry out the work)	US (who need to know in order to be able to carry out the work)
TO ACHIEVE?	INSTRUMENTS to control and coordinate activities and resource utilization	A STATE OF READINESS AND FLEXIBILITY IN ACTION based on an insight and knowledge of problems on the part of all who can influence the outcome of the work

Figure 1. Two ways of looking at planning.

as rest factors. They are natural resultants of the plans. This view of planning is the dominant one at the present time, largely as a result of the "Industrial inheritance" from scientific management and production engineering in the manufacturing industries. This planning philosophy also met the current demands of the market for long series projects, for example large housing estates based on simple variations of a basic dwelling unit (apartment or terraced house).

There is also a relationship between the company's organisation on the one hand and its planning philosophy on the other. The head office organisation was fairly stable and company plans were based on available personnel resources there. The pressure for high production with relatively limited variation in product encouraged specialization and a variety of specialist departments began appearing in head offices, accompanied by the development of professionalization amongst the staff.



The site organisation on the other hand has an essentially temporary character and site plans were based primarily on the available technology. Far from being stable, the principle of redundancy of parts would seem to have characterized the social system, i.e. the manning of the site was continually changed to match the mixture of tasks contained in the time schedule. 1)

As has been pointed out the conditions facing the building companies have radically changed and more and more companies are becoming aware of the fact that the planning technology and philosophy of the fifties and sixties are "outdated" and dysfunctional - there is a need for new control instruments and new organisational guidelines to enable building companies to cope efficiently with their new environment. The recent legislation entails that the social resources in the company can no longer be utilized as its main adaptive resource. This is a further reason why adaptability must be built into the technical system to a greater extent. Their companies must be characterized by a high level of flexibility in their organisations and in their planning at both the strategic and operational levels. There must also be a readiness on the part of all parties to continuously evaluate past experience and experiment with new ideas, i.e. there must be a readiness to continuous learning. One example of the way in which such flexibility may be attained is to extend the competence of the individual so that it encompasses a greater number of tasks and skills than he is called upon to carry out or utilize in any particular assignment. This strategy is sometimes referred to as the principle of redundancy of function. Thus for example instead of hiring and firing shutterers at different stages of the building project they may be given the opportunity of learning tasks carried out by general building workers and carpenters so that by switching between these tasks their own security of employment is increased at the same time as resource uncertainty is decreased and flexibility increased for the company.

A third main feature of the basis of this study concerns how the required changes may be achieved, the development strategy involved. We feel that any basic change requires learning on the part of the parties involved and such learning involves their generating experience which is then structured and that these new concepts and modified frames of reference

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1) The principle of redundancy of parts' is formulated and explained by F. Emery in "Towards a Social Ecology" (1973).

are tested out in new action: A process which is continually repeated in a development spiral. In other words learning is an iterative process. This view of learning has been popularly termed "Learning by Doing" or "Action Learning" and this project draws heavily on the ideas and experience accumulated in a series of such projects. One of their key features is that individuals, groups and companies learn from and with each other by tackling their own immediate problems.

#### Aims of this study

The principle aim of the project is to get the personnel, management and labour unions in three construction firms involved in a continuous learning process via an action-orientated change study of their own organisations.

One main objective is to work on improving the company's control instruments by attempting within the framework of a specific building contract to develop

- the level of participation and influence of the personnel in the company,
- a more project-orientated way of planning and production in order to increase all participants knowledge of the total construction process and thereby achieving a more integrated work process,
- a planning perspective focused on planning more as a way of developing experience, knowledge and individuals within the framework of a specific building project and less as a way of producing a single plan, i.e. a final product consisting of the sum of a series of historical data or time elements,
- a way of planning where organisational aspects are given as much weight as the more technical aspects,
- forms of work scheduling where the building workers broad competence is better utilized and which leave room for motivation and influence over that day-to-day planning and production processes.

A second main objective is to develop the total organisation of the firm in order to

- open up patterns of communication both inside the company and between the company and its environment, i.e. its market, the labour market, consumer demands etc.

### The conduct of the research project.

A basic idea in the project is that it is a joint venture between the separate parties involved, the researchers, the members of the companies involved and the main parties in the labour market in the building industry. (There are three main union organisations, the building workers' union, SBAF, the supervisors' union, SALF, and the salaried staff's union, SIF. In addition there are two employers' confederations, the one organising house building companies, SBIF, and the other civil construction firms, Sveabund. Many of the larger diversified companies are members of both employer confederations). This co-research strategy is most clearly seen in the division of roles between the company members and researchers in the project work. The companies' representatives in the research project have a clear responsibility for defining specific problems which they intend to study, for collecting their own data and recommending (and even carrying through) action on the basis of the conclusions drawn from their analysis. In addition to their more traditional research activities the researchers have a responsibility to facilitate the work of the company project group. This entails assuming different roles in different situations as the project develops. Some of the roles which the researchers expect to play are: consultant, discussion partners, spokesmen, mediators, "Pacer", teacher, administrator and assistant to the project group in the collection, analysis and spreading of different information.

The labour market organisations as users of the research are involved in the project through representation in a special reference group. In addition to the representation of the labour market organisations this group also contains representatives for the researchers and the companies involved (in the person of their managing directors). This reference group meets quarterly to evaluate developments in the project. It has appointed a working sub-committee which has more frequent contact with the researchers for a more extensive exchange of ideas and information about problems and issues in the project. The members of the reference group are also prepared to participate as consultants and discussion partners in the project work in the individual companies.

The research project is also a joint effort between different groups within individual companies. Thus the research project involves parallel efforts on different system levels in the company, i.e. both at top management and production levels. The project work is anchored in natural groups with the intention that the development activities regarding their work are assigned equal status to other tasks and are allotted specific resources. The natural groups involved in this study are the company's top management group and the production management group for a specific building contract. In the former case the management group is extended to include union representatives when issues of direct relevance to personnel are discussed. In the latter case the production management group is extended to include representatives for the site workers. An important factor in the organisation project in individual companies has been to avoid excluding any hierarchical level from representation in the two main groups working within the framework of the study. Thus all organisational levels from the site workers to managing director are represented either in the production management group or the top management group.

The research project is also a joint effort between the three companies involved. The integration of the development efforts is attained by arranging residential workshops for the planning and evaluation of the research work. Such workshops are held approximately every other month for the production groups and every six months for the top management groups. Each workshop lasts approximately two days and is attended by the entire membership of the relevant group from each company and all the researchers. The workshops provide the opportunity for developing and testing new ideas, rules, concepts and techniques in site and company management. They also provide the opportunity for the participants to work in different groupings, e.g. in-company groups, professional groups (e.g. all site agents) and in mixed groups (e.g. contract manager from company A, site manager from company B and ganger and planner from company C).

What has happened in the project so far?

Gaining the backing of the labour market organisations.

Figure 2 gives a rough picture of the main activities in the project to date. It took roughly eight months to launch the project. This period may be characterized as one of intense negotiations between the researchers and the other parties involved, namely representatives for the labour market organi-



zations and management representatives in potential participant companies. The design of the project also constituted an innovation for the Building Research Fund and its board reserved funds for the project on the condition that three companies were willing to participate and that we could indicate which benefits would accrue from the project for the industry as a whole. (There was some feeling within the board that the research strategy constituted company consultancy and thus that the costs of the project should be defrayed entirely by the firms participating.)

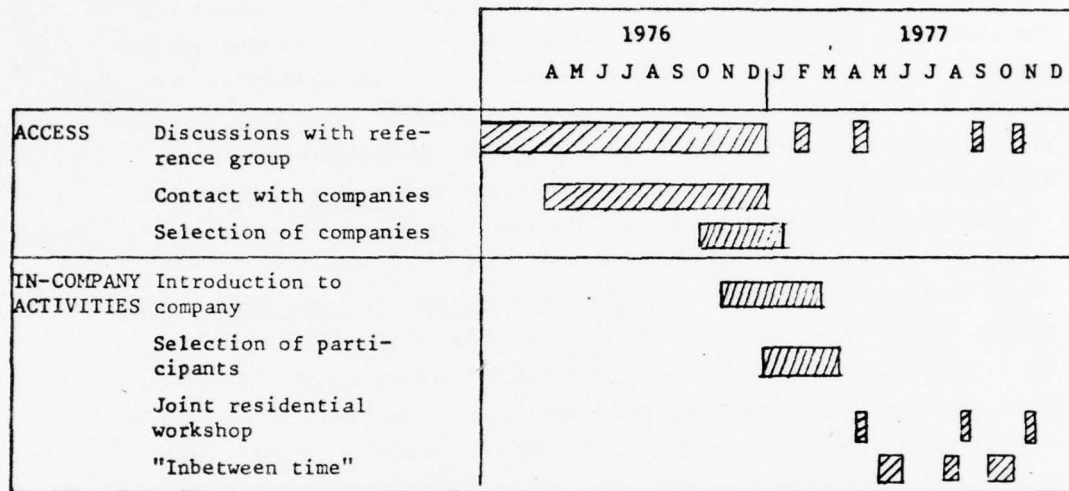


Figure 2. Main activities in the project to date.

This research project formed the natural continuation of a study of planning in building companies carried out from 1974-76 by Jan Pärsson and Sten Penhoffs. In this study they carried out longitudinal case studies of two building projects to establish the main factors determining the planning technology in a company and the resultant effects of this technology on production, work organisation and work situation of site personnel. The reference group in the current project had been constituted in this initial project. Much of the work with the reference group during the initial project had concerned the members' individual frames of reference with regard to the values behind and implications of their own planning philosophies. The reference group played an active part in the planning of the present project and had a clear understanding of the researchers' frame of reference and what they aimed to achieve. (It is probably true to say that the majority of the members of the reference group shared the researchers' frame of reference.) The reference group also felt that the research proposed

by the researchers was of a direct relevance to the problems facing the building industry today. The Building Workers Union had however one serious doubt regarding its participation in the project. The new Swedish legislation on co-determination which came into force on the 1st of January 1977 implies that the workers' participation in such company issues as production planning are now open to regulation by a joint agreement between unions and management organizations. In Sweden it has generally been a union principle not to officially participate in research projects concerning issues which are currently the object of negotiation. Such action may give rise to a situation in which the union's negotiation position may be threatened or its freedom of action limited by the results of "its own" research efforts. In our case the union decided to continue its involvement in the project but underlined that the results of the research could in no way constrain the policies and plans of the union formulated in accordance with their normal procedures.

#### Gaining access to companies.

Swedish building companies are very management orientated in their images - their managing directors and the divisional managers are strong and often colourful personalities. Thus the researchers initial contacts with companies were mainly with these key individuals. Roughly a dozen firms were contacted during the late spring and early summer 1976. Only three or four firms politely declined to participate following this initial contact, for reasons that it was either too similar or too unlike current in-company projects. Contacts continued with six - eight companies over the summer and into the autumn. This entailed presenting the project and its underlying frame of reference for different key individuals and groups in the companies concerned. It was a disadvantage for the project that it was much easier for potential participants to conceptualize the costs involved in the project than its possible benefits. The decision to participate was also an equation with too many variables for many firms. It required support from key figures in top and middle management, suitable potential contracts and the possibility of establishing a suitable production group to match both the building contract and the research project. In autumn 1976 the researchers were worried that they had "oversold" the project - at least half a dozen companies had expressed their desire to participate. However, four suddenly withdrew due to unforeseen circumstances. Two of the firms merged and both withdrew from the project. A third company withdrew when it changed managing directors. Two companies were owned by the same corporation

and the corporate management felt that the project only motivated the participation of one company.

The experience of action learning programs inspired by the work of Reg Revans has strongly influenced this project. This work has shown that individuals' learning is facilitated in a learning program if they are given the opportunity of working together with people from different companies and functional backgrounds at regular intervals during the program. This was the main reason for wishing to include three companies in the study. This had also the advantage of being able to select firms which had different distinctive competences (and markets) - a house building firm, a civil construction firm and a firm specializing in renovation projects. A second criterion in the selection of firms was that they would geographically be close to each other to facilitate between-company visits and the participation in residential workshops. The third criterion was that the companies be acceptable to the parties on the labour market. (Both the unions and the employer confederations requested the exclusion of specific companies as unsuitable for the experiment for company policy reasons.) In principle the companies participating were to be selected by the central reference group. In practice, natural selection prevailed - only three companies accepted to participate by the deadline set by the Building Research Fund. Fortunately these three companies complemented each other perfectly in fulfilling the criteria formulated by the reference group regarding their size, area of business and geographical location.

#### Establishing the project in the participating companies

Our first activity in the participating companies was naturally to present the project for a wider circle of people than those with whom we had negotiated our entry. In the house building company this took the form of meeting a regional planning group to which several additional personnel representatives had been invited. The company followed up this meeting with a short notice concerning the project in their in-company journal. In the civil construction company the project was presented to a special meeting of contract managers, site managers and staff representatives. In the building renovation company the project was presented at separate meetings for a) staff representatives and site managers and b) gangers. In the latter two companies representatives for the local regional offices of the unions participated in the presentation of the project to confirm and explain union support for the project.

The central feature of the research project is that a production management group works with a specific contract. The first basic issue in the project within the companies was: Should we select the project management group or the contract first or how do we select them in parallel? The house building company had a very capable production group who had developed its own planning and control system. When first deciding to participate in this study the company saw as a prime objective that other groups should become acquainted with (adapt) this system and hoped that this research project would provide the necessary opportunity to realize this diffusion process. In addition, the group in question was working on a contract building day nurseries for several local authorities. The building of such nurseries has been marked as a priority area in the public services development program and the company was also anxious to develop its specific competence in this expanding market.

In the civil construction company priority was given to the selection of the individuals in the production group. The project concerned was secondary with the possible qualification that it should give a reasonably good impression of the company's efficiency. The underlying reason for the company's participation in this study was to develop the company generally. The decision process in the building renovation company was a parallel one, concentrating on both the selection of the contract manager and the type of project involved. The company, which is family-owned, and had previously financed most of its own activities, experienced that political developments implied a shrinking market for speculative building and they were anxious to expand into new markets. The project they chose, hospital renovation, was a relatively new market for them and seemed to offer promising prospects.

The managing directors of the companies involved met together with the researchers to discuss the selection of projects and production groups. At this meeting it was agreed that the production groups selected be working with projects which were expected to be completed by late summer - early autumn 1977. The first months of the project would then give the opportunity for the group to analyze and structure the experiences they had won during the the project and give them the opportunity of testing out the lessons they had drawn in a new project commencing in the autumn of 1977 and continuing through 1978. The project would then give the opportunity for two iterations in the learning spiral.



### The residential workshops

The real launching of the project in the participating companies took place with the first residential workshop. We believe that these workshops are an important facilitator of the participants' learning for a number of reasons:

- The personnel categories represented in the production groups represent different professional cultures. By working together in a learning situation they are provided with the opportunity for gaining an increased awareness of others' frames of reference and values and for heightening their receptivity to others' views and experience.
- Besides representing different professional cultures they represent different company cultures (values, norm structures) of which individuals are more or less conscious. Again the workshops provide the opportunity for a conscious perception and questioning of these cultures.
- Symbolically the work shops provide concrete evidence to all members of the companies involved of the sanctioning and status allotted the development efforts in this project - it is not just something to fill idle moments on the site. Practically speaking, it provides the major opportunity individuals have to work intensively with the project, analyzing past experiences and planning new action. The motivation and satisfaction for this intensive effort can also be heightened by selecting attractive physical settings in which to hold workshops.
- Working together with professional colleagues from other companies means that decisions taken on planned action in the home-situation are commitments made to peers, professional colleagues, and not to researchers. Such commitments are more likely to be honoured.

What did the participants do at the first work shop? The work shop started with a dinner for all participants Wednesday evening and finished with lunch on Friday, almost two days later. The first evening was spent in professional groups where participants discussed the conditions under which they worked in the separate companies. This general warming up to the work shop continued in the sauna later on. On Thursday the participants worked in mixed groups using a problem analysis technique, synectics, to analyze specific issues they would work with in the project and to generate ideas as to how these

	COMPANY A	COMPANY B	COMPANY C
TYPE OF PROJECT	New Production of Day Nurseries	Renovation of Hospital	New Construction of Bus Maintenance Depot
WORKSHOP PARTICIPANTS	Contract Mgr Site Manager  Ganger Planner Training Manager	Contract Mgr Site Manager  Ganger Estimator	Contract Mgr Site Manager Ass. Site Manager Ganger Estimator
CLIENT	Local council	Regional administration	Public utility
REMAINING PROJECT TIME	5 months	5 months	2 1/2 months
CURRENT STAGE IN PROJECT		Furnishings and Fittings	Site works

Figure 3. Participants and Projects at the first residential workshop 27-29 April 1977

could be tackled.<sup>2)</sup> The technique was a new one for all the participants and the day started with an illustrative example in a plenary session. The basic steps in a synectics exercise are:

1. Starting from the formulation of a general problem the members of a group brainstorm different subissues or facets of the major problem. As in brainstorming no evaluative comments are allowed in the first step. The main problem in our illustrative exercise was: How can we tackle the issue of undermanning on site? The first step resulted in 24 subissues.
2. The group selects the two or three most important subissues by an iterative process in which each participant individually assigns a priority to several subissues which are then discussed in the group. A new selection is made from the subset remaining and so on.
3. For each (or the single) important subissue remaining after the second step the brainstorming step is repeated, this time regarding possible measures which may be taken to deal with the problem.

2) For a more detailed description of synectics see Rickards, T. "Problem Solving through Creative Analysis". London: Gover Press, 1974.

4. The possible measures are then sifted to arrive at the best one in the manner described in step 2.
5. The three most important advantages and the most important disadvantage for each proposed action are listed.
6. How to eliminate or tackle the most important disadvantage.

The participants were divided into three mixed groups and spent the whole day on the synectics exercise starting from the main problem: How can we use this research project as a means to become better builders? The groups literally papered the walls with their suggestions so that they could simply and quickly get up to date on their colleagues progress by wandering round "reading the walls". The groups produced between 20 and 50 subissues from this problem reducing this number to approximately 3 in each group. The participants met in plenum after the second step by which time the following priority questions had arisen:

- How can the work in the project be organized to give practical results?
- How can we assess our strengths and weaknesses?
- How can we reward a "good" client?
- How can we achieve a diffusion of our experiences both within and outside the company?
- How can we promote technical innovation and development in the company?
- How can we build up feelings of responsibility and involvement on in all members of the company?
- How can we acquire a better understanding of others' work?
- How can we achieve better client involvement in project specifications?
- How can we better materials flow on site?
- How can we improve the working environment on site?

It was decided that each group would tackle a different problem in the first instance in steps 3 and 4 in the synectics exercise. The issues tackled were:

- How do we build up feelings of responsibility and involvement in all our personnel?
- How can we assess our strengths and weaknesses?
- How shall we go about getting anything practical out of this research project?

When discussing the fourth step in the exercise the participants in each group agreed on which measures they would take in their own companies and report back

on at the next work shop. This constituted the cross-company peer commitment we referred to earlier.

On the third day the groups met in in-company groups to discuss their plan of action up to the next workshop. The plans of action in specific companies were naturally similar (as a result of the mixed group commitments) and included the following types of measures:

- Attitude surveys (regarding necessary changes) among workers, subcontractors and building inspectors.
- Different kinds of follow-up of the current projects,
- diaries regarding on-site contingencies, problems, innovations, and issues raised by workers.
- Studies of the information flow and division of responsibilities between contract managers and staff specialists in head office,
- gangers involvement in on-site production meetings and meetings with clients, inspectors etc.,
- photography of key incidents, situations etc., that illustrate the issues taken up in the diaries,
- regular news sheets on development in the research project within the company.

The development activities in the day-to-day work.

What action had in fact been taken in the two months from the workshop until the summer vacation? The production management group building the day nurseries has not met together since the workshop but has worked intensively in several different subgroups. The site agent has been the main figure in these activities. An attitude survey has been carried out amongst all the site workers and the results of this have been discussed at two feedback sessions with the workers. In addition the researchers have carried out depth interviews with the different members of the production group regarding their values and experiences not only in this project but in the company and in the industry in general.

The management group was then presented with an edited but unanalyzed report containing depth interviews, the questionnaire results and the minutes of the workers comments on and discussion of their answers in the survey. This report with its qualitative information about the production forces view of what is regarded central as issues was a new experience for top management and increased its involvement in the project.



The production management group in the civil construction company held weekly meetings (with written minutes) for the first month following the workshop. They then decided that fortnightly meetings sufficed. They too have carried out an attitude survey and have taken measures to deal with some of the problems indicated in the survey, e.g. the need to replace certain tools and machines. They have also evaluated their current project, grading the subcontractors (for the first time ever), checking the economic outcome and going through the estimates of certain jobs together with the ganger.

The production management group in the building renovation company has met twice. It is in the process of carrying out a company-wide survey regarding priority issues for change and the researcher has interviewed subcontractors and building inspectors regarding their evaluation of the company's performance. The ganger now participates in production and client meetings on site and has also participated together with the other members of the production group in a follow up of the estimates used in the project tender.

**Table 1. Workers' ranking of issues that need improving on site**

	BUILDING RENOVATION	NEW HOUSE PRODUCTION	CIVIL CONSTRUCTION
Dust on site	1	(1) x	1
Noise on site	2	(1) x	1
Clearing up on site		2	3
Changing Rooms/Canteen	3		
Information on new projects (contracts)	3	4	
Storing of materials		4	
Accessibility on site			4
Form of employment	6	3	
Wage form	5	6	
Light on site			5
Union activity on site	6		
Wage level		6	
Tools and equipment			6
Cooperation on site			7

x) These two issues were grouped together in the questionnaire in this company.

Table 1 shows the priorities assigned different areas by the workers in the three projects concerned in the research. Factors concerning the physical working environment are assigned highest priority in each case.

Those individuals whom we included in the top management groups in the three companies have been selected in each company but the group in the civil construction company is the only one to have met before the industrial holiday. This group conducted a synectics exercise regarding the internal efficiency of the firm.

### Some first impressions from the project

The decision processes involved in the companies approached to participate in the project could well be said to have followed March, Cohen and Olssons garbage can model, i.e. the ideas presented by the researchers constitute a solution which has been matched against the problems facing managers contacted. The decision to participate in the project has depended partly on the existence of any match between problem and solution and partly on the political influence of the problem holder promoting our solution. The ideas behind the project were formulated in rather abstract terms and were related to a frame of reference which was foreign to a number of the managers contacted. This meant that many individuals interpreted the project in a highly personal way and were motivated in their decisions to participate or not by different factors, for example the relevance of the development strategy in our frame of reference, the perceived competence of the researchers themselves and the relevance of their past experience, and the relevance of the skills and experience, policies and practise of the management in the other companies which would probably be participating in the project.

Considering the work in the production management groups it is fair to say that up to the second residential workshop three months later, the research project was still something very special. The member of the production management groups did not see any clear coupling between the abstract frame of reference and general formulations of the research project and the concrete day-to-day activities in their work on a site. "The research project was one thing, my job was another." Thus the researchers felt that they were taking most initiatives at this stage while they are now taking few as the project is getting under way.

A clean example of the change in aspirations and attitudes in the project is the formulation of the plans of action drawn up by each productions group at the end of the residential workshops. These plans were much more action oriented and were related in a very direct manner to their day-to-day activities after the second meeting when compared to the first. For example general measures of type "Keep a diary over important events" became less prevalent than those of type "Ganger will participate in site meetings with building inspectors and subcontractors".

One aspect of this general problem is that problem solving is only to a limited extent consciously seen as an occasion for learning or group development. For example when the delayed delivery of certain furnishings

and fittings occasioned the postponement of the hand-over date in one project by two weeks and caused a radical reshuffling of activities on the site, the production management group decided to shelve "research and development activities" until the storm had been weathered. The situation was not seen as an occasion to provide insight for the head office specialist in line management's work situation. The follow up of the situation afterwards, in learning terms, lost a certain amount of its value as the situation had not been consciously approached with this perspective. "There was nothing special about the crisis, we got by as usual".

Yet another aspect of this problem is that it is difficult to identify development issues "of the middle range". Many of the minor problems which are dealt with in the day-to-day activities on site are regarded as so trivial that they are not worth mentioning. Those issues and problems which spring automatically to mind are often major questions which can either not be rectified within the frame work of the current project or else require resources and involvement from not only the production management group but even many other individuals inside and outside the company. A typical example here concerns efficiencies and inconsistencies in the project specification from the client. (It is our ambition that such issues may be tackled in the new contracts to be started in late autumn 1978.)

Learning and problem solving are also hindered in some cases by existing forms, structures and climate in the participating companies. For example one company is quite proud of its streamlined procedures for meetings and guidelines for their minutes. Without wasting a second the meeting moves from problem to problem noting decisions and outcomes. Unfortunately the speed of the meeting seems to have become an end in itself and no room is given (as yet) to discussing how the reported solutions were arrived at. In another company, feedback to individuals implying or indicating alternative values, perspectives or courses of action from those held or taken in the past is regarded as negative criticism or confrontation rather than an expression of positive interest in individual and group development.

An essential element in the design of the project is that production and top management groups work on their development efforts in parallel. In all three companies initial efforts were confined to the production groups. It was their progress reports to their superiors which kindled top management's interest and even enthusiasm to take independent and/or supportive steps in its own context.



The production management groups tended to function less as groups and more as collections of individuals - specialists who each do their own thing. But by the second residential workshop there are already signs that they are beginning to work together on some development questions. This integration of the production groups has been facilitated by the joint evaluations each group has carried out of the contract it has recently completed: What went right and what went wrong and why? These evaluations have been carried out in broader fashion than usual. Economic data have been complemented with qualitative data on suppliers, subcontractors, quantity estimates, planning and methods of work. These evaluations have led to new approaches to estimating and planning the new project e.g. by including gangers and workers in the planning groups.

The activities in the research project are so far confined to the development groups in the individual companies. Crossfertilization between companies has yet to emerge. The participants are still very involved in the "special" or "distinctive" character of their own personal situation. The diffusion of information and experience within the participating companies is as yet still an idea.

THE CONSTRUCTION INDUSTRY -- A MORPHOLOGY

by

Thomas F. Boland

## THE CONSTRUCTION INDUSTRY - A MORPHOLOGY

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### TIMS XXIII INTERNATIONAL MEETING

#### ABSTRACT

This paper describes the construction industry as a device invented by man to supply him with constructed facilities. It then proceeds to describe and represent the construction industry in relation to its environment and also to describe and represent it as a system. The latter description is completely independent of the mechanics of the individual processes within the system.

The paper demonstrates the practicability of viewing the industry in this way prior to attempting to examine the feasibility of applying Management Science Techniques to it.

The paper goes on to suggest that the morphological representation developed can provide a common reference framework within which research and development and, in particular, management science techniques can be discussed both nationally and internationally.

#### INTRODUCTION

The construction industry is the device invented by man to supply him with constructed facilities. Man requires constructed facilities to satisfy certain of his needs. As these needs grow and become more complex, greater pressure is exerted on the construction industry to increase its supply of constructed facilities and also to provide constructed facilities with ever increasing and more involved functional requirements. Man therefore is required to apply his reason to modify his constructed facility supply device to meet the new demands made upon it. This being the case it is fair to say that man becomes the agent of metamorphoses of the construction industry.

On referring to Figure 1, one will observe that the evolution of the construction industry through the process of rationalization has resulted in it having become metamorphosed into certain entities according to the ever evolving status of technological development. These metamorphosed entities can or might be identified as being:

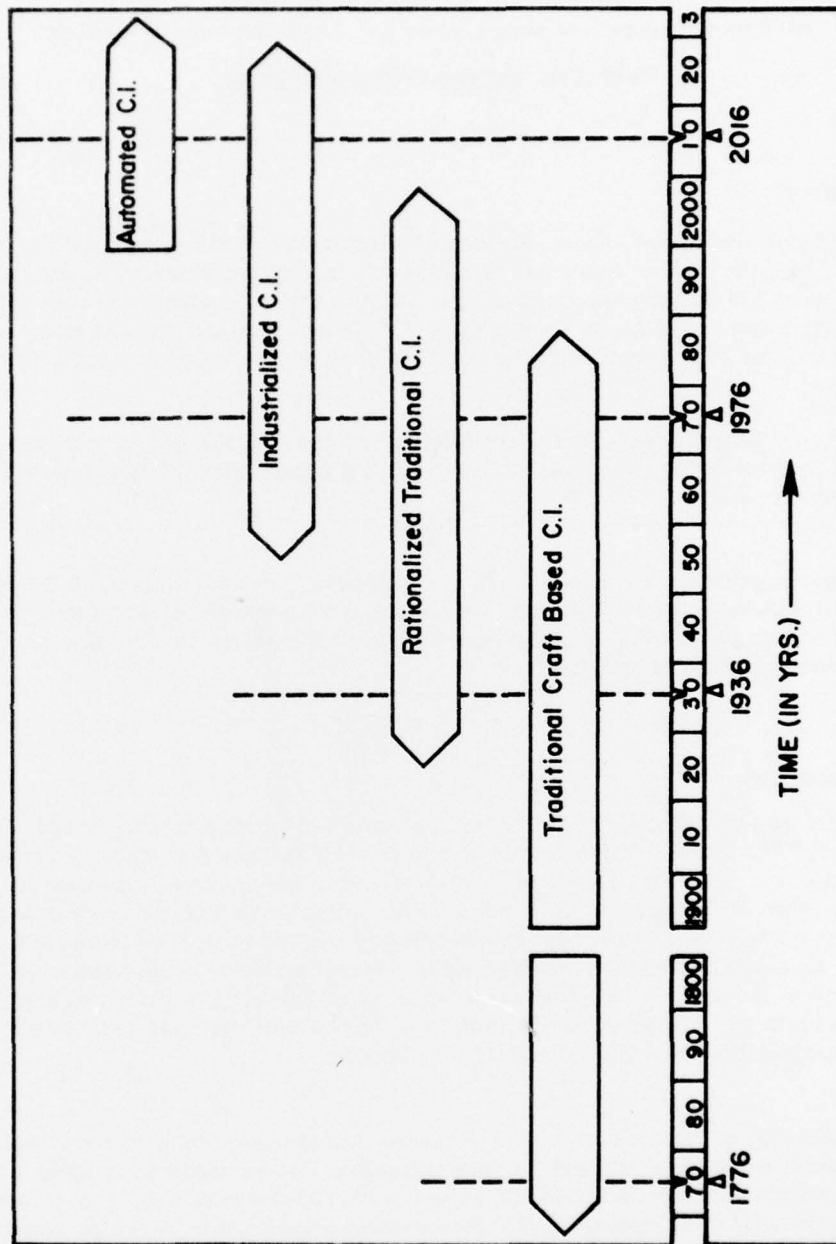


Figure 1



- a traditional craft based construction industry
- a rationalized traditional construction industry
- an industrialized construction industry
- an automated construction industry.

It is important to be able to contemplate the construction industry as an instrument of man that fulfils a function. It is important also to have a common mental perception of the construction industry itself when discussing, researching or applying management science techniques to it or any of its constituent elements or processes.

This session of the 23rd international TIMS meeting is devoted to 'Contributions of Management Science Techniques to the Construction Industry', yet very few people, if any, have a common mental perception of the object "Construction Industry". Reference to a dictionary will not help. Is it feasible, therefore, to ask for discussion on the benefits of applying management science techniques to something that is not fully understood? It seems fair to suggest that the true potential of research and, in particular, management science techniques for the construction industry cannot be adequately realized unless the construction industry as a physical object can be described and represented in meaningful and acceptable terms.

The purpose of this paper is to provide a study of the form and structure of the construction industry as an object and as a system and so provide the description and representation that is for so long wanting. This paper may therefore be described as a morphology of the construction industry. The term morphology may be defined as:

"That scientific study concerned with the form of an object, system or process and the structures, homologies and metamorphoses which govern or influence that object system or process".

It is hoped that this study will provide a base reference framework and common denominator for future research and discussion on the construction industry.

#### **BASIC FUNCTION OF THE CONSTRUCTION INDUSTRY**

The basic function of the construction industry is to provide constructed facilities. It was created by man to fulfil this function so that certain of his needs may be satisfied.

Although the beginning of the construction industry is somewhat obscure, it is possible to examine the constructed facilities it has provided and so bring to notice what changes, if any, are inherent in its function. For example, the first large-scale constructed facility in stone was the Step Pyramid of Zoser in Sakkara, Egypt. This was built around 2778 BC by Imhotep for the purpose of giving shelter to the body of King Zoser and the sustaining commodities deemed necessary for his eternal enjoyment. In contrasting this with contemporary constructed facilities whose purpose is to satisfy the human need of providing shelter, we find the only difference is that emphasis seems to be more on the living human body.

Thus it will be observed that had a morphological study been conducted and a description and representation of the construction industry been developed some five thousand years ago, it would still basically hold true today. Thus a description and representation developed today of the form and structure of the construction industry is most likely to benefit man well into the foreseeable future.

#### THE CONSTRUCTION INDUSTRY VIS-A-VIS ITS ENVIRONMENT

Ordinarily when imparting to a child the knowledge of the location of his environment, one starts by selecting a reference framework that will form a base upon which all future geographical discourse with the child can be referenced. One such explanation, full augmented with visual aids, might be:

"Our experience is limited to the Universe. Within the Universe, there are a number of star clusters or galaxies. One of these galaxies is called the Milky Way. A member of the Milky Way is the star known as the Sun which is very familiar to us. This star has nine planets orbiting around it, the third closest of which is called Earth. It is on the planet Earth that we live".

This logical deduction can, in a way, be paralleled when explaining the construction industry as part of man's environment. Man within his environment seems to be evolving under certain "life" forces and will continue to do so for as long as he acknowledges those forces and consciously responds to their demand.

Also, man has many needs ranging from the basic physiological to those of continual self-fulfillment. In order to satisfy these needs, he has created a number of institutions and industries. These institutions and industries can be graphically represented in relation to each other. Thus, the physical structure of man's organized environment may be represented in a fashion similar to that portrayed in Figure 2. Here it will be observed that the central controlling body man created for his environment is the institution we call the Government. Around this institution and controlled by it are the many other bodies man deems necessary to satisfy the remainder of his hierarchy of human needs.

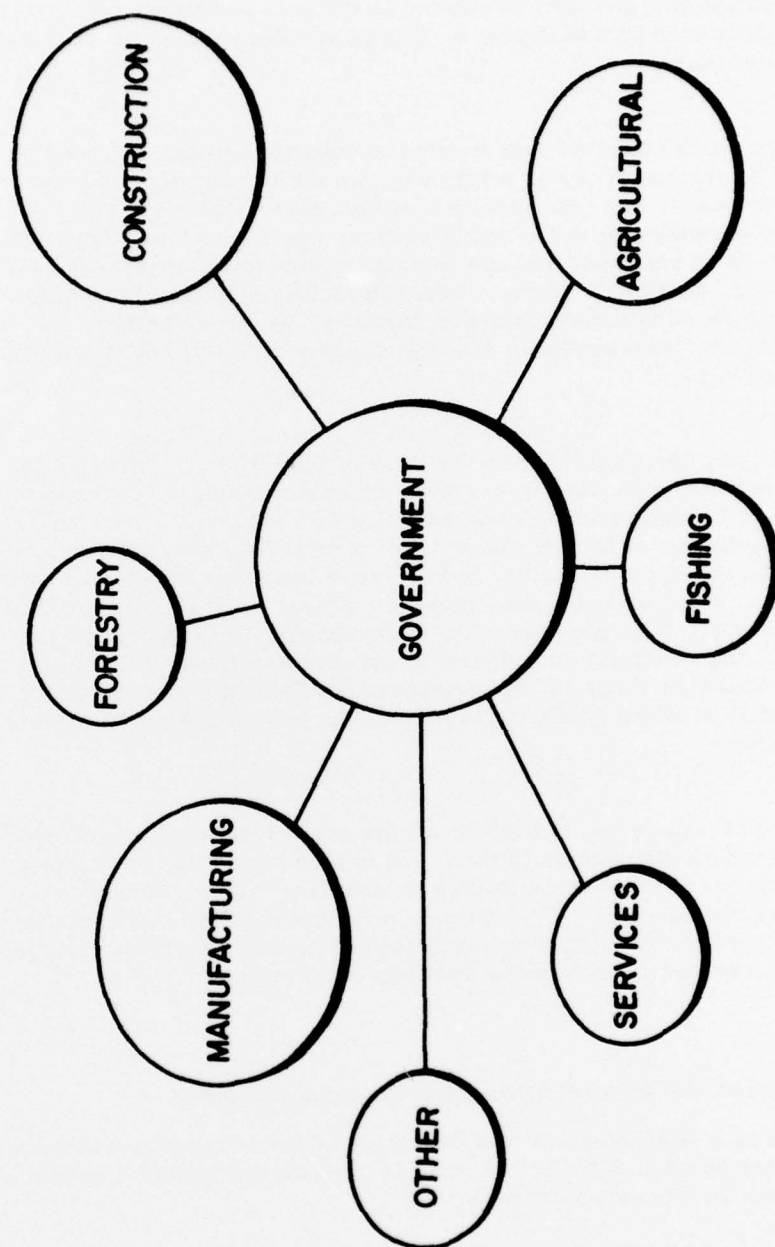


Figure 2

Once the physical environment is logically structured in this way, it is now possible to focus attention on any individual body within it and subject it to individual examination. For example, the item of interest as far as this paper is concerned is the construction industry. Thus, by focussing on the construction industry as represented in Figure 2 and by reproducing it in magnified form as shown in Figure 3, it is possible to analyse it in relation to its environment.

Here it will be observed that firstly the construction industry may be regarded as an inanimate object orbiting within the environment and controlled by the government, and secondly as a system that enables the process of transforming materials, with the aid of energy, into constructed facilities to take place. It is important that one should be prepared to regard the construction industry as a device of man. This allows the development of a representation of the construction industry devoid of the human being. Tackled in this way, the representation developed will lend itself better towards objective analysis.

Further consideration of Figure 3 will reveal that the construction industry is activated by a request from within the environment. This request, ordinarily, is for some particular constructed facility and the industry responds by endeavouring to satisfy the request by providing what it understands the particular constructed facility to be. It is important also to consider the activating agent as being the result of a process that takes place in the environment. It is not necessary in developing a morphological representation of the construction industry to get involved in the multiplicity of the factors that take place in environment and influence the type and form of expression of this request. This should be considered as a separate area for research.

However, it is not just sufficient for the construction industry to exist and become functional when activated. It is also necessary to ensure that it will continue to exist and continue to function. Thus, there is a necessity for a sustaining agent. In Figure 3, money is portrayed as being this agent. It is brought into the system in response to requests by it for compensation for its efforts in satisfying the demands made on it.

#### MORPHOLOGICAL REPRESENTATION OF THE CONSTRUCTION INDUSTRY

Figure 4 is a morphological representation of the construction industry. Here it will be observed that the structure of the industry consists essentially of three generic processes, namely:

- A basic process
- A managerial process
- A support process



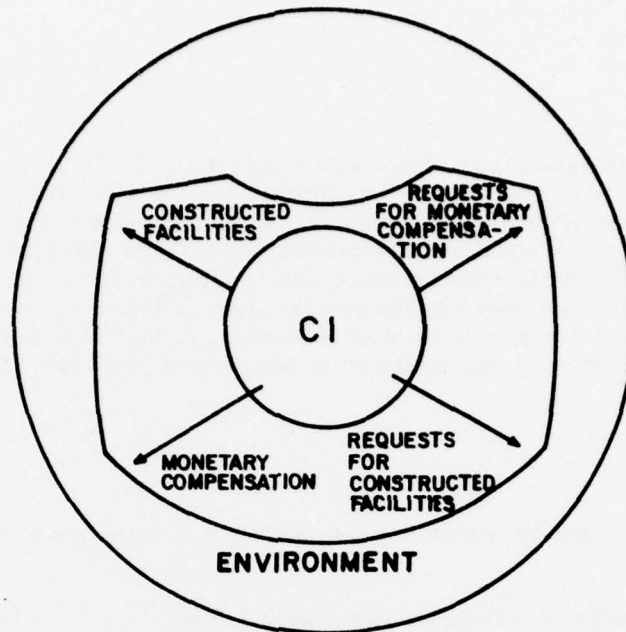


Figure 3

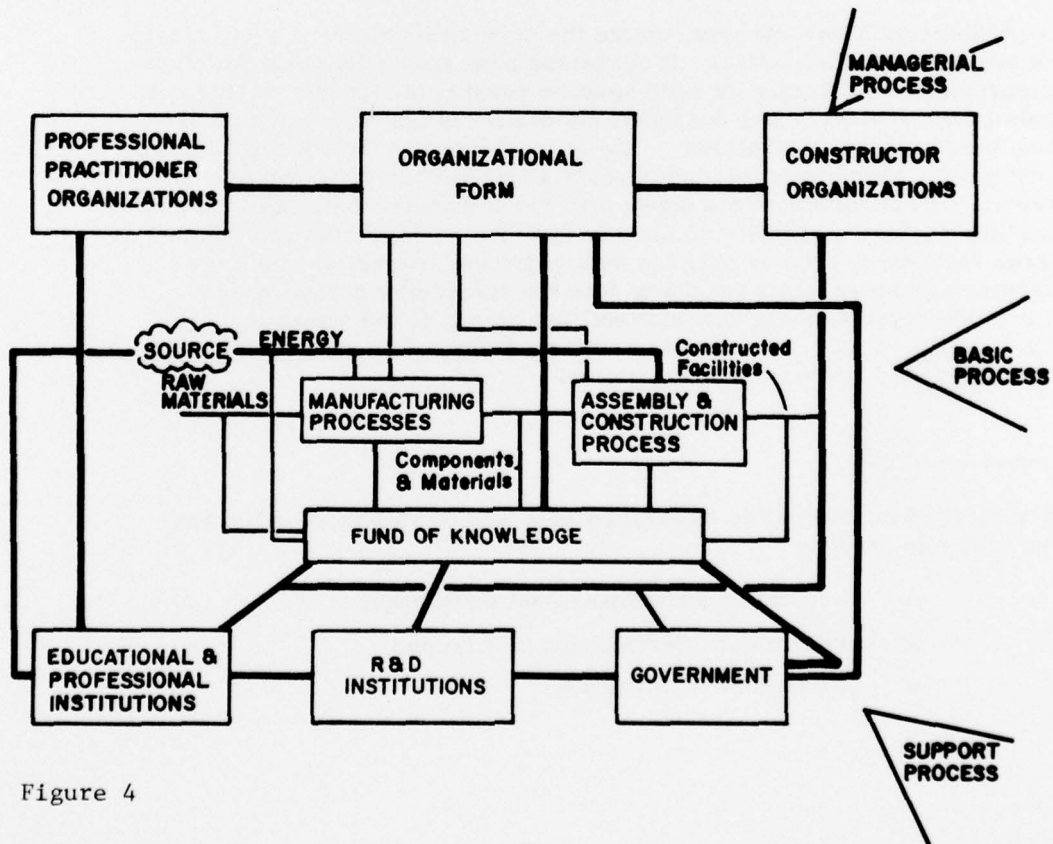


Figure 4

#### **The Basic Process**

This process consists essentially of two sub-processes. In the first, raw materials, with the aid of energy, are transformed by a manufacturing process into different materials and components. In the second sub-process these new materials and components are transformed with the aid of energy by an assembly and/or construction process into constructed facilities. This basic process is represented by the central plane in Figure 4. It must be pointed out that the energy may consist of anything in the range from that produced by manual labour to that produced by the most sophisticated machinery.

#### **The Managerial Process**

This process, represented by the upper plane of Figure 4, consists of three major elements:

- Professional practitioner organisations
- Constructor organisations
- Organizational form.

The organizational form element, unlike the other two, rarely, if ever, exists as a separate business entity. It comprises some particular combination of designers and constructors for each specific constructed facility or group of constructed facilities. The designers are ordinarily drawn from the professional practitioner organisations - these are deemed to include any professional design divisions within organisations that provide their own design service. The constructors are drawn from the constructor organisations or departments where organisations provide their own construction services. In some instances, such as package deal or turnkey operations, both the designers and constructors are drawn from the constructor organisations. Yet it is the organizational form element that exercises the managerial process as well as other sub-processes such as design. Its existence usually terminates on the completion of the project.

#### **The Support Process**

The support process consists essentially of a fund of knowledge and three major elements, namely:

- Educational and professional institutions
- Research and development institutions
- Government departments.

These are represented by the lower plane of Figure 4. The educational and professional institutions endeavour to fulfil the function of providing an education for the personnel involved in the system.

Developing, reorganizing and applying knowledge and ensuring its availability to all elements within the system and influencing the evolution of the construction industry is the prime concern of the research and development institutions.

The Government has a definite role to play within the system. This role takes many forms and ranges from direct injections to the sustaining agent to making it mandatory for certain elements within the system to comply with specific information within the fund of knowledge. The fund of knowledge itself is the store for all information that is at the disposal of all elements within the system.

Closer examination of Figure 4 reveals that the representation contains more than a mere portrayal of the various entities. It also contains a structured organization of these entities, together with a representation of the relationships that exist between them. The development of such a morphological representation is of considerable benefit in that it allows for:

- Analysis of the system as a whole
- Analysis of individual generic processes
- Analysis of individual entities
- Independent analysis of the communicating structures
- Analysis of the metamorphoses which govern or influence the system
- Analysis of the homologies, of the elements and communicating structures.

#### CONCLUSION

Once the construction industry has been described and represented, a base reference framework is established to which can be related any future discussion on the industry, its elements or processes. For example, with regard to the application of management science techniques one might wish to consider where their application to the basic process might best be considered. This study can be carried out completely in context by focussing and magnifying different portions of Figure 4. Figure 5 is a magnified reproduction of the Organizational Form portion of Figure 4 in conventional terms.

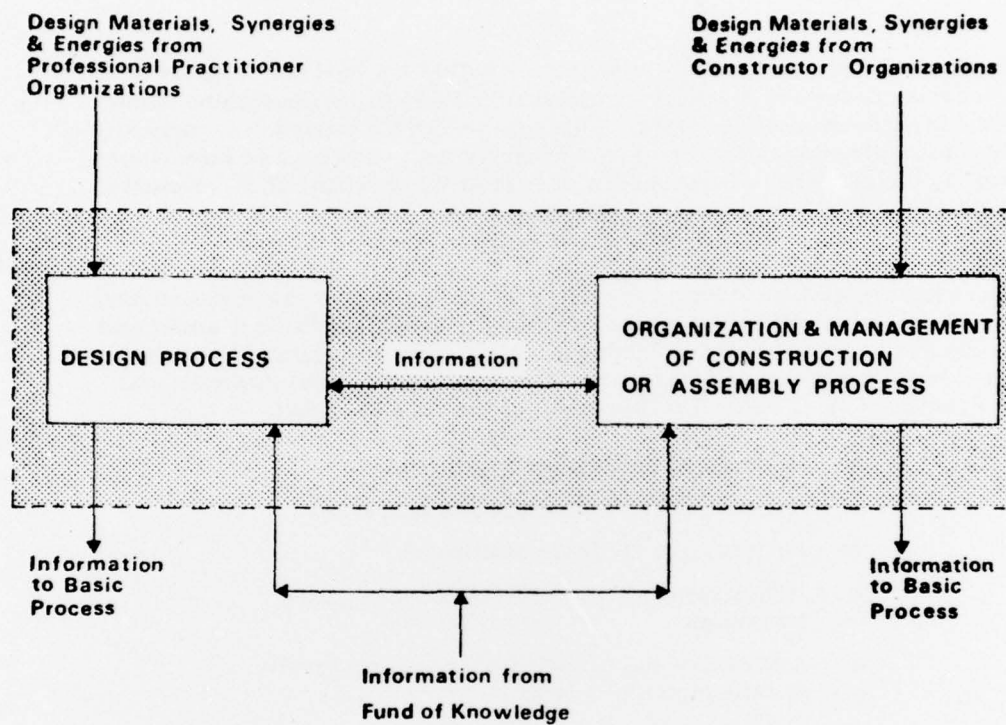


Figure 5



In this magnified reproduction it will be observed that the "Organization and Management of Construction or Assembly Process" is a pertinent area to examine.

On studying the proceedings of the many congresses, symposia, seminars and colloquia of the major international research organisations, it will be observed that all management science techniques deemed applicable to the construction industry have been suggested at one time or another, either in their purity or with modification for practical application. However, general acceptance and implementation of the techniques has been inhibited, it would appear, for the want of a common understanding of:

- the device the "construction industry", its individual processes and its elements,
- the communicating structures within the industry,
- the agent of metamorphoses within the industry,
- how predicted results of studies will affect the industry and hence the environment.

The morphological study carried out in this paper, although incomplete, is a positive step in endeavouring to form a generally accepted understanding of the above listed items. It is true that the description and representation portrayed of the industry may be considered as being over simplified because in practice it is fragmented throughout the environment. This is true, but is it possible to conduct a comprehensive study of an object by concentrating on its individual fragments without regard to the coordinated workings of these fragments? It could be argued that the greater portion of research for the construction industry has been concentrated on its individual fragments. If this is so, then it is possible that progress within the industry has been somewhat retarded by an over-emphasis on micro-research and insufficient attention given to macro-research.

April 1977