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THE BUILDING PROCESS

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A. THE DESIGN PROCESS GIVES THE INFORMATION FOR THE ERECTION

Every single operation and every single component is a part of a big jig-saw puzzle. No requirement, decision or operation can be looked at in isolation, no optimation can be made unless as part of the optimation of the process as a whole. Only the final product, the completed home, has a value in itself.

Therefore, the design process is definitely tied up with the construction process - and good design without a thorough knowledge of the erection technique is impossible. Great care must be taken to ensure the practical feasibility of the decided design by close collaboration between client, architects, engineers and contractors from the initial stage of a project to the occupation.

Thus, the design must be geared to production.

I can refer to my paper on Design Philosophy in which the reasoning is dealt with in detail and in which a list of the design activities is given in the appendix. This organized design process is an important part of the building process.

Provided the principles of the design process are adhered to, all information required for the site operations should be ready by the end of the design process.

How the different parts of the design has been divided between the parties involved is of no importance, in so far the information exists, checked and co-ordinated, before the start of the erection.

The information shall be complete and available and covers:

1. From client, authorities, banks, design staff
   - Building permits
   - Finance programme
2. From design staff (& contractor)
   - Drawings
   - Specifications
   - Quantities

/3. From

3. From design staffs, planning staffs (+ contractor)
   Cost and labour analysis
   Corresponding time schedules and working plans
   Site arrangement
4. From client, design staffs, planning staffs, contractors
   Contracts with suppliers, factories, etc. including delivery-time schedule etc.
   Contracts with main- and sub-contractors, including time-schedules, etc.
5. From design staffs, contractors
   Erection techniques, tolerances, principles of setting out, etc.
   Erection gear, crane, etc.
6. From client, contractor
   Control organization, supervision, etc.

The attached diagramme on Work Planning-Site Management indicates substantial parts of the above, somewhat more detailed, but attention is drawn to the fact, that this diagramme is worked out on a basis of logical division and thus does not indicate the relative importance of the different items.

As an example working plans for finishing, (A.2-6) covers working plans for manufacture and delivery and installation (three possibly "independent" operations and/or sub-contracts) for a very long range of components and materials of any kind.

Site arrangement, preliminaries B.1.1. covers a great number of applications, permits, agreements, operations, checking, etc. as well as general information and arrangements.

To this work planning diagramme must be added the activities of design described in the paper "Philosophy of Design and Adaptation to Production in Industrialized Housing".

Design - Planning - Erection - Relationship

It may be seen that the design process covers two main aspects, firstly what is generally understood as design, secondly planning of all operations. Furthermore, that the design is thorough: drawings are actually shop-drawings, all details and operations are specified, and the practical feasibility in factories and on site is checked upon. Partly, this means knowledge of the techniques of each sub-contractor - if not direct

/collaboration during

collaboration during the design process - partly this means a close collaboration between the design staffs and the planning staffs of the parties involved.

When erection begins, the drawings and specifications form the firm basis together with the work planning. During the erection process and finishing processes, control and checking is exercised with regard to quality in all senses of this word and with regard to the working plans and schedules. Schedules may be slightly revised, especially after the running-in period, and the work planning is thus a continuous link between the two given ingredients of the complete construction: the design and the erection.

This emphasizes the importance of:

Site management as the sole link between design staffs and sub-contractors when the site management exercises its power, based on the work planning.

Still, human beings make mistakes, and instead of listing the ideal organization, it may be easier to give a list of typical mistakes as a warning. Usually the real reason for mistakes is a simple misunderstanding of facts or relations between facts - or because a Mr. Know-all came to the site.

B. SOME OF THE FREQUENT REASONS WHY PROJECTS WENT WRONG ARE:

The inaccuracies were not under control due to lack of specified tolerances

The principles of tolerances were not correct

The tolerance system (setting out and check) was wrong (examples: single dimensions were within limits, but the inaccuracies were allowed to build up intolerable inaccuracies for a series of components)

The check on tolerances went wrong (or were forgotten!)

The climate was ignored. Precautions were not taken in time for extreme (but statistically rare) conditions (heavy frost, heavy rain, heavy wind, etc.)

The joints were not sufficiently suspiciously analysed.

/The suppliers

The suppliers or sub-contractors did not keep up to time-limits (why did not the main-contractor check the suppliers stock 5 months before start? He knew the delivery time was 5 months!)

The labour productivity was wrongly judged

The crane capacity was wrongly judged

The running-in-period was misjudged

The roads were not ready

The telephone company began digging for cables accross access roads when the job was just about to be run-in

Initial difficulties were handled the lazy way: Never, never accept the gold old reasoning: Operation X is not very good now - but as we can repair the faults, we shall have better results when the site is run-in. Operation X will then never be run-in. Take the faulty construction down, lose time by that, instruct better (analyse!) and try again. This has the psychological effect of cutting down the running-in time. The time and money lost initially will come back fast.

The site was not instructed, checked or supervised sufficiently well (which also includes unnecessary acceptance of delays, sub-quality, as well as reluctance to analyse and revise)

The site was too clever. The site management changed operation X to a simple (or cheaper or faster) operation, ignoring the change in quality thus achieved (maybe because the site-management did not know all the reasons for operation X). Not a single detail can be changed without consulting those who designed and decided. Any detail is part of a complex pattern - and any operation X may on purpose be a bit difficult in order to make other operations far more simple.

The list of valid drawings did not exist, was not distributed or was ignored, so that the gangs worked from older drawings (or did not look at all drawings).

<u>Working plans, time schedules, etc.</u>

These lists and diagrammes (maybe worked out from a critical path, maybe fitted to electronic data processing, maybe based upon other principles of logic) must be worked out as an integral part of the design process.

/Thus, site

Thus, site planning and erection techniques should correspond to the designed components and houses.

Rate of erection

Generally, the time-limits and all schedules are based upon the cranes and rate of erection of the structure

The type of crane can be analysed:

The site conditions, the size of components, the number of lifts (do not forget the extra lifts of "other components", gear etc.) and the speed of erection (according to the clients wishes) forms the basis for this analysis.

If in doubt, take the heavier, more rigid crane.

From this analysis will come a type of crane and a corresponding number of flats or square metres to be erected per day.

Roads, sewers, foundation, basements, must be constructed to be ready in time for each block. In cold climates the heating-plant shall be ready before the finish shall take place in the first dwelling.. Better add a safety margin! If the heating plant is not ready in time, the cranes may erect the structure according to time-schedules and the site management is in an unpleasant situation!

All operations after the erection of the structure, the finish and completion, must be delayed until the heat is on. Psychologically this has a bad effect: apart from the delay - serious as it may be - the influence on the labour is general disregard of any future time limit, which means that the delay of occupation will grow day by day from block to block.

This will also happen if one - just one - of the basements is not ready when erection should take place on top of it. Add safety margins for extreme conditions of soil, weather, etc.

Finishing

The operations which follow the erection of the structure shall be planned to follow the erection. If the cranes erect 5 flats per day, any following operation must also be carried out for 5 flats per day. Obviously, the finish cannot go faster, and if any finish operation goes at a lower speed, the finish operations are delayed, and the occupation time is delayed more and more for each block.

/The finish

The finish can be analysed from the given conditions: X flats per day and Y operations per flat. From this comes a necessary crew, to be judged by experience, time studies, etc.

Collection

Finally the relationship between all the necessary operations must be analysed.

The sequence of operations must be examined. Sometimes another order of operations is advantageous.

The required space - in area and time - for each gang must be judged.

The relations between the different gangs must be analysed. Some must, some can, some cannot, some will not work in the same area simultaneously.

Safety

This is quite obviously important, too often ignored. This applies to handling of cranes, gear, material, components as well as to personal safety of the labour.

This point also covers the statical problems, which are usually carefully examined for the completed structure, whereas the different stages during the erection quite often have been ignored (or the designer forgot to specify safety measures during erection or forgot to check on the actual erection techniques).

D. SITE MANAGEMENT

The site management is the key to the success. The staff must be sufficient, experienced and capable of the job.

The site Manager

The information necessary for the definition of the construction has been supplied by the client, the design staffs and the planning staffs. To this can be added building codes, standards, etc. Part of the information may have come from sub-contractors, suppliers or specialists, part of it from the main-contractor, but the decision, the final specification came from the client or his advisors, acting on his behalf.

/The defined

The defined construction is carried out by main-contractor(s), sub-contractors, factories, suppliers, by their technical staffs, managers, foremen, labourers, clerks, etc.

Thus the bits of the jig-saw puzzle have been defined by a large group of more or less independent people, co-ordinated by the design leader, and all these bits are now, combined in a somewhat different way materialized by a similarly diversified group.

With traditional methods and at a lower rate of erection a certain independency is possible between all parties involved, as well as between the particular operations.

With industrialized methods, (with any bit pre-fabricated or pre-defined to the smallest detail and with any operation fitted into a close pattern) a definite, central control is essential.

The logical answer is:

Client - Architect - Consultant Engineer - Specialists
supply information, decisions, drawings to the
Site Manager
who administrates and controls the activities and operations of
Factories - Suppliers - Contractors

The site Manager as the sole link between "specifications" and "execution" is the only guarantee for a smooth, efficient construction on a site, which is virtually a fast working assembly line (with many individual operations and labour-groups, gangs) for the fitting-together of a fast, closely timed delivery of many different pre-finished components from many sources.

Nobody can logically criticize such an organizational pattern, although personal pride may be against it, for example due to the fact that the supervisor and the design staff must communicate through the site manager, definitely not directly.

The organizational pattern

The main problem in this respect is the possible conflict between "management" and "quality control".

The client must ensure that he gets the right quality, in time, at the right prices, and the authorities must ensure that the structure corresponds to the structural calculations and the Building Codes. In other words,

/the supervisor

the supervisor from the consulting engineer must be able to check the quality, to stop the construction if necessary and to refer to his design staff or the authorities whenever necessary.

If arranged properly and beforehand (in the contracts) these conflicts can be minimized. All supervisors can refer on management to the site manager and yet maintain the right to direct appeal to the client and his advisors or to the authorities.

This direct appeal shall only take place when necessary, i.e. if the site management (or the contractor) is unwilling to make good failures, etc. Any such action must of course - anyway always - be simultaneously to the site manager.

The client must arrange this organizational pattern.

(a) The client may be the builder and the contractor as well in one person. If so, he is responsible to himself and the problems are of minor importance (Building Codes and authorities are still to be satisfied).

(b) The client may build by means of a number of independent contractors, each with their contract on their part of the job. If so, he has established himself as the main-contractor, and the site-manager is on his own pay-roll. Again, there is no conflict between "management" and "quality control".

(c) The client may buy a package-deal or may deal with one main-contractor. If so, the site-manager is usually on the main-contractors pay-roll, and the client must then establish that his supervisors accept the site-manager as the key-man, centralizing all management, as the sole link of management between "specifications" and "execution".

The supervisors of the client and his advisors (design staffs if any on the clients pay-roll) must fit into this pattern on management, but must have direct appeal - copy to the site manager - on control of quality (if the problem is not solved on site). Checking on bills, quantities etc. also come into this pattern, possibly the same way as control of quality, but dependent upon the terms of contractors.

(d) Any division of management responsibilities between several, although brilliant, persons must be avoided. If necessary, great care must be exercised when establishing a divided pattern, a possibility which may exist if all parties are more trustworthy, positive and idealistic than usual.

/The difficulty

The difficulty is rarely to solve the organizational pattern or to get the site manager accepted by all parties, but to find the right man. It is a new kind of job, very diversified in nature, covering more aspects than any main-contractor usually has handled before. Experienced men are few, but may be found anywhere in a technical office, not necessarily within a contracting organization.

The site staffs, supervisors and management staff, must exceed the usual size, dependent upon the efficiency of the men (or women) and the size of the site, but 5-6 people is about right on top of the technicians and foremen the contractors usually have. Quite often, the cost effect shocks the client on the first job. On the second it does not. It was worthwhile.

Documents and forms

All management of this kind obviously means paper. All agreements are written down and circulated, all check-ups are listed, all minutes of meetings are circulated to a large number of people, to say nothing of all the drawings (complete sets for each sub-contractor - made up especially for him, only indicating his operations - including the tender documents as well as subsequent revisions, maybe indicating price-revisions). To this can be added the bills of quantities, the running accounts and bills, probably payable when the (part-) operation is complete, and the revision of prices and of tenders (due to variation in price-indexes of various kinds for goods and labour and due to revisions of specifications or quantities).

In order to file and circulate this kind of information correctly, forms must be worked out (and signed) on revisions, extras, agreements etc.

The application in practice

1. Client, advisors, lawyers, architects, consulting engineers, specialists, design staffs, development groups communicate (decisions, drawings, information, payments) to the site manager, who spread the received information to the appropriate parties.

2. The site manager acts through three channels:
Architectural supervisors
Engineering supervisors
Management staffs
Psychologically his main job is to establish team-work and run it.

3. Revisions
The initiative may be taken by anybody
The site manager controls the activity
All parties (clients, design staff, sub-contractors) directly or indirectly affected shall comment and agree to the decision before the revision is effective.
Revisions may also be extras or other changes in the contract basis.

4. Architectural supervisors
Check on quality, performance and execution
Information on this (well in advance of regular meetings) to the site manager
Check on quality, fulfilment of codes, etc.
- information to site manager
- appeal to client and authorities if necessary

5. Engineering supervisors
As architectural supervisors

4.5. Direct contract between supervisor and design staff
Allowable with the consent of the site manager in each particular case - and provided the site manager is kept up-to-date. But the irregularities begin here and the central management may slowly be undermined. As an example by revisions not circulated to or agreed to by other parties more or less affected. The guarantee for the exact fit between a particular component and the rest lies with the site manager, but all parties, also the design staffs (including planning staff) must agree.

6. Administrative staff
General organization and administration of the site
Order on site
(Small, but important example: Are all suppliers by contract-specification continuously taking their packing and containers away? If not get an agreement)

/Check, revisions

Check, revisions on time-schedules etc.

Registration forms to be filled out

Registration of experience (of any kind) to be filled on forms.

Feed-back to design and planning staffs (and possibly to sub-contractors)

Check on preliminaries in advance, agreement if necessary

Supply of gas, water, electricity etc.

Public and other roads, sewers etc.

(Very well in advance as public activities sometimes are a bit un-planned or not timed)

Check on factories and suppliers in advance

Production programme, machinery, moulds, stocks, ordering etc.

(Well in advance, especially on items where the delivery time is usually long or new manufacturing techniques)

Ensure the supply can take place in time.

Check on reserves and spare time to ensure continuity also under extreme conditions (winter as an example)

Prepare agendas etc. for regular and incidental meetings with groups of contractors (client, design staff etc.)

Check, revision, circulation of valid drawings and the corresponding up-to-date list of drawings.

Economic arrangements (possibly for clients decision)

Bills, quantities, payments

Suppliers of components from the client to main-contractor (if any such contracts exist)

Control of factories and supplies

Quality, quantity, present and future programming.

7. <u>The site manager</u>

Responsible for:

Directly for this administrative staff (6)

Indirectly (but finally) for supervisors (4-5)

Responsibilities:

Current information of progress (to client and contractors)

/Decisions, acting

Decisions, acting also as appeal court
Organization, site arrangements
Time-schedules
Information must be correct, available, up-to-date and sufficient
Check on missing information, delayed deliveries, activities
Check on needed information, components, deliveries etc. so well in advance that future continuity is ensured
Chairman of a number of regular meetings (maybe weekly) with different groups of related sub-contractors
Chairman of regular meetings between client, design staffs and site. (The client may wish to take the chair, assisted by the site manager)
Feed-back of information and experience gained to client, design staffs, planning staffs, etc. - in order to get better results on later parts of the scheme, and on following schemes.
The good atmosphere of team-work - under his control
Generally responsible for the application in practice of the planning described above.
See diagramme WORK PLANNING-SITE-MANAGEMENT

E. DEGREE OF MECHANIZATION ON THE SITE

This is usually decided upon from available information on local conditions and possible manufacturers.

Quite often this analysis tends to be on the conservative side, as most contractors underestimate or are afraid of new, unknown techniques.

I would rather conclude, that a firm belief, followed up by firm decisions may prove the pessimists to be wrong - and prove advanced methods to be competitive in spite of any analysis.

This may be natural in the industrially developed countries, but it is quite often also the case in less developed countries, usually due to the better training and control of the labour, which is possible in factories and on well-organized sites.

/The labour

The labour may be completely technically unqualified. If trade unions are positive, men may be trained to do a good job on repetitive operations. However, the most important qualification is a sense of responsibility and understanding of quality - also of the quality in other labourers jobs.

The lack of tradition of hand-craft in some countries enforces the necessity of education of the labour to understand and respect quality, before the actual training of the labour technically. Again, this is easier to do when organization exists, in factories and on industrialized building sites.

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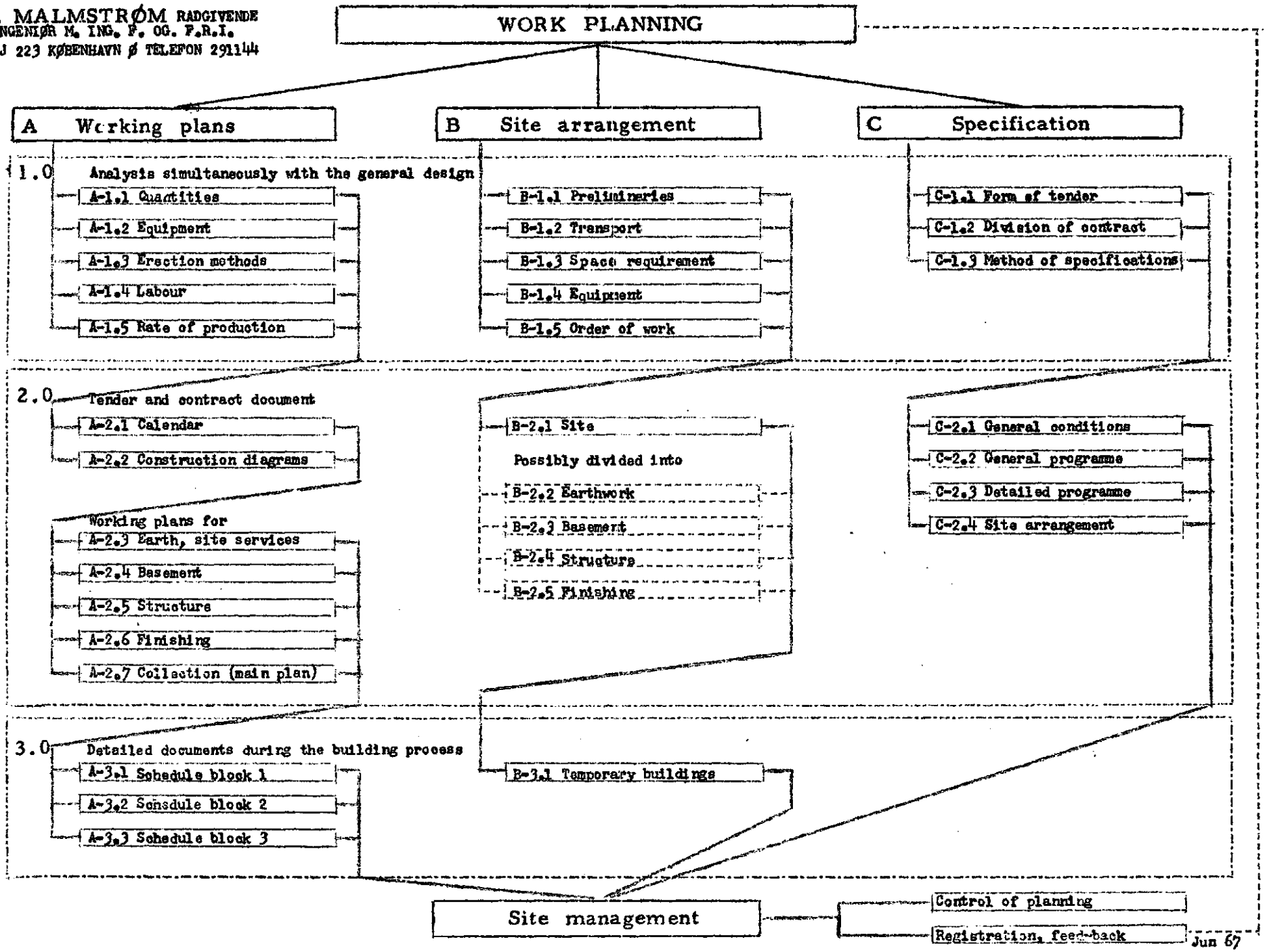

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