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Fascicule 10

THE CONTRACTING SYSTEM IN DANISH CONSTRUCTION: PINNING DOWN AUTONOMY

Sten Bonke & Peter Levring

Department of Planning - Section for Construction Engineering and Management Technical University of Denmark

Groupe Bagnolet

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Le Groupe Bagnolet - c/o Graham Winch - Bartlett School of Graduate Studies
University College London - Gower Street - London WC1E 6BT - +44 171 387 7050

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RESUME

L'industrie de construction danoise est très fragmentée, avec un grand nombre de petites firmes spécialisées et quelques très grandes entreprises capables de couvrir tous les aspects du processus de construction.Les concepteurs (architectes et ingénieurs) sont, en revanche, concentrés dans quelques grandes agences.

Les deux dernières décennies se sont caractérisées par le besoin pressant des entreprises de construction de s'adapter aux changements radicaux des conditions du marché. L'état de maturité du marché de la construction et le développement de l'économie ont, dans l'ensemble, contribué à réduire le niveau d'activité du secteur, alors que par ailleurs on assiste à une croissance de la demande de rénovation qui représente actuellement à peu près 50% des activités.

L'approche danoise de la construction est depuis longtemps tournée vers l'industrialisation, des d'immeubles de grande hauteur construits dans les années soixante jusqu'aux grands projets actuels de rénovation. Cependant, la productivité stagne et la qualité semble, elle aussi, poser un certain nombre de problèmes.

En conséquence, l'Etat danois s'emploie à promouvoir des initiatives pour améliorer la productivité et la qualité dans tous les champs d'activité de la construction. Ce rôle avait précédemment été assuré, avec beaucoup d'impact, par des mesures législatives, par le soutien direct au développement technologique et par des actions générales de formation et d'éducation.

Les partenaires du processus de construction ont réussi à se mettre d'accord sur les règles "communes" qui doivent guider la réalisation des projets. Les conditions générales sur lesquelles les contrats sont basés sont régulièrement mises à jour dans le cadre d'un consensus entre les différents partenaires.

Les arrangements contractuels ont évolué au fil du temps, des contrats traditionnels impliquant plusieurs entrepreneurs au contrat de type *conception et construction*, représentant l'approche industrielle. Aujourd'hui, aucun modèle ne domine le marché et les entreprises du bâtiment travaillent sous différents types de systèmes contractuels, projet par projet.

Cette contribution passe en revue les différentes tendances technologiques ainsi que leur rôle institutionnel dans les marché d'après-guerre. Les relations gestionnaires et contractuelles dans les pratiques de construction danoises sont également analysées.

INTRODUCTION

This paper is mainly concerned with the institutional framework of the Danish construction industry, describing structures, rules and actors' roles within a perspective of nationally defined procedural guidelines on construction projects. In the following these aspects are treated under the concept of a "contracting system".[1]

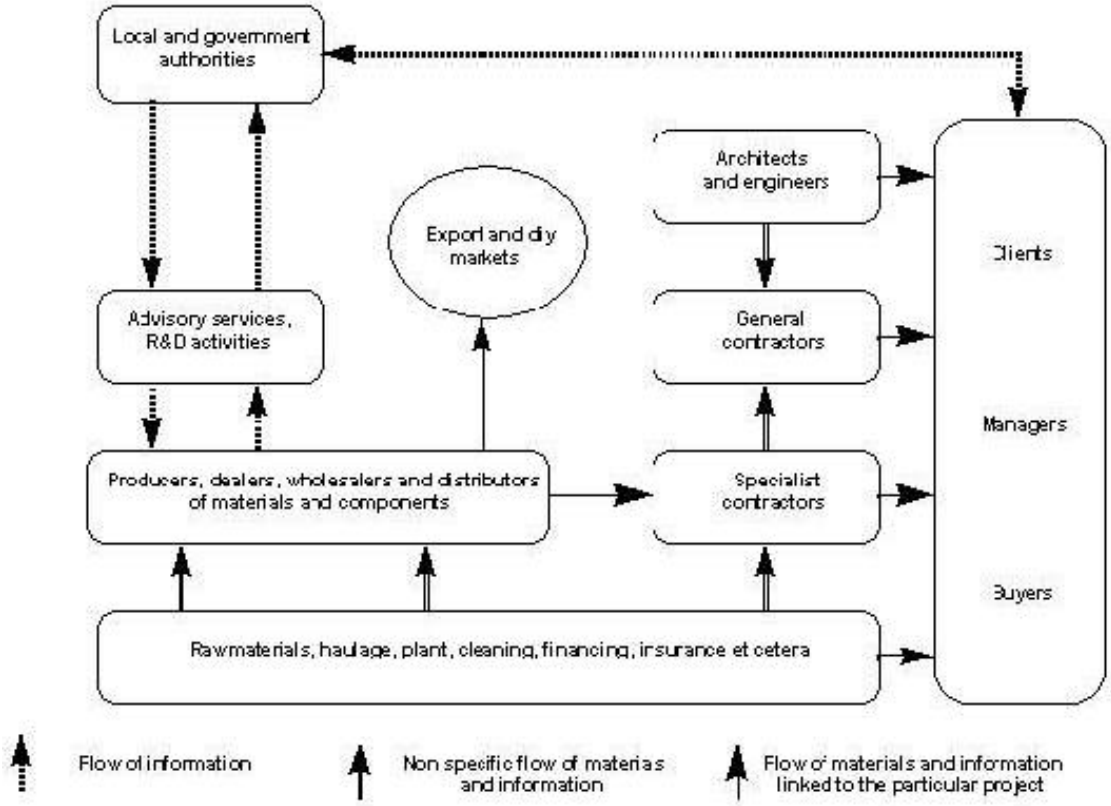


Figure 1 The Value Chain in Construction

Like in most northern European countries several basic features of the Danish system carry evident traces of Anglo-Saxon and Anglo-American provenance. However such, mostly formal, reminiscences of international influence, are in no way adequate indicators of the nature and functioning of the construction process. At least two other types of general mechanisms could be indicated as having been shaping more profoundly the practice of construction: firstly on a Scandinavian level, the effects of the social-democratic society model, which is known to represent tight bonds between state actors and industrial parties as well as highly regulated labour market relations. Secondly, a particular national cultural phenomenon, the characteristic anti-centralistic behavioural attitude, which in specific contexts clearly allows autonomy to micro actors in the construction process.

Rather than intending to present an analysis of the exact mix of influential currents in the Danish contracting system this paper goes into details with facts and procedures on the specific level. This hopefully provides basis for an understanding of crucial elements and coherences of the system.

Initially in the paper is given a short introduction to the structure and activities of the Danish construction industry. Hereafter the post-war development of the industry is

[1] The Groupe Bagnolet operates with five such distinctive contracting systems, each exerting decisive influence in specific fields of the large construction projects which have been studied in the different countries. The concept is elaborated more theoretically in Working Paper 6.

reviewed, in particular emphasising the importance of the early industrialisation process, which in an international perspective represents quite unique features. At the end of this section is indicated the most recent development trends in the industry. A third section of the paper describes the contemporary external, regulative framework of construction projects. In the two final sections the construction process is decomposed with regard to 1) phases and activities and 2) procurement forms, actors and functions.

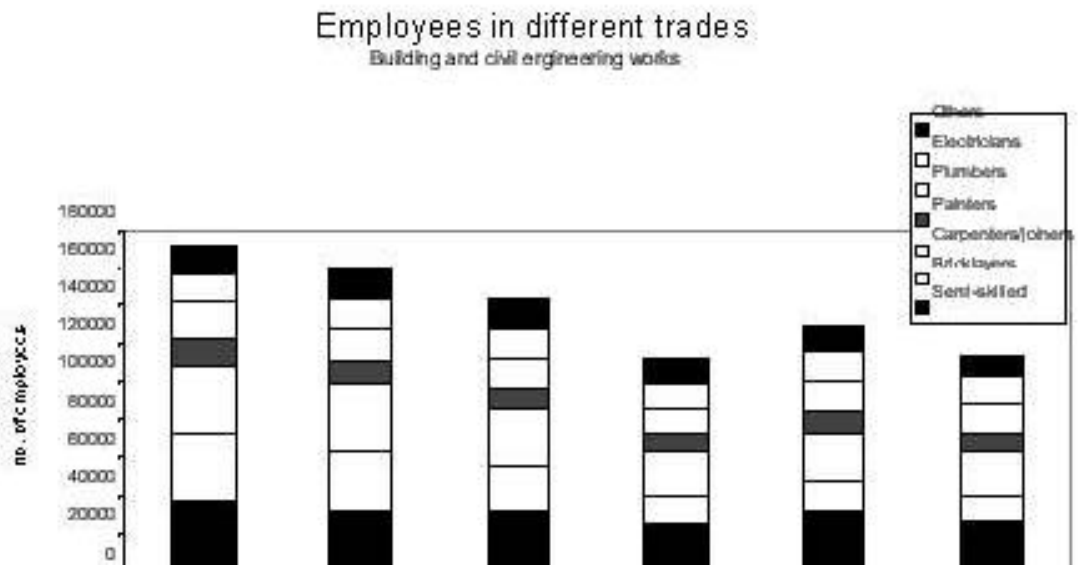


Figure 2 Employees by Trade (including civil engineering)

Source: Statistics Denmark

The content of the paper will primarily focus on the public and private provision of new and renovated homes and on the private procurement of buildings. This market perspective must be considered in distinction to larger public works in the field of civil engineering. Nevertheless, and for obvious reasons, there is a strong relation between these two segments of the construction market in Denmark, since the main actors most commonly work in both areas. Consequently much of the information given throughout the following chapters *also* applies to the civil engineering sector.

The construction industry is a very complex sector consisting of a large number of actors related in many ways formally and informally. The main parties of the construction industry are normally defined as *architects, engineers, contractors and suppliers*. Their position in the value chain can be illustrated in the manner shown in figure 1.

THE INDUSTRY

The number of persons employed directly in the construction industry is around 135,000. The material-, service- and supply industry employ approximately an additional 55,000 persons. The number of companies directly or partly involved in construction is approximately 24,000. The industrial structure is dominated by a large number of smaller and traditionally craft-based companies. Labour-only subcontracting is rarely used in Denmark. The breakdown of employment in the industry by trade is given in figure 2.

The number of companies working directly in the building industry as architects and engineers is approximately 2,500. Also this design and planning field is quite specialised by trade. Especially some consultant engineers companies have grown quite large with more than 1,000 employees and are working world wide.

PRINCIPAL ACTIVITIES

At the present time the main activities of the sector are divided into two main segments - renovation and new building activities which each cover roughly half of the domestic

activities in the industry. The absolute and relative importance of renovation activities has been gradually increasing during the last decade primarily due to the ageing of two large building stocks from respectively the beginning of the century and from the 1960s. In 1990 the turnover of the industry as a whole (including civil works) was approximately DKK 160b.

From an export point of view the material and component producers have been very successful in recent years. Though the companies in this field are relatively small on a European scale exports from the sector have achieved a national economic importance comparable to that of Danish agriculture. The aggregate level for the industry's exports was in 1994 amounting to over DKK 29b with the export of building materials responsible for more than 60 %. During the 1990s the level of the export has stabilised at a very high level between DKK 25 and 30b per annum, as is shown in table 1.

The export trade is concentrated in building materials characterised by a high level of quality, design and durability and therefore at the price-heavy end of the market. Danish firms have been particular successful in wooden products and interior fittings.

	1992	**1993**	**1994**
Producers of materials and components	13,226	12,390	13,359
General contractors	3,852	4,256	4,178
Specialist contractors	1,554	1,337	1,413
Trading	5,885	4,753	4,737
Architects and engineers	5,443	5,328	5,407
Total	**29,960**	**28,064**	**29,094**

Table 1 Danish Construction Exports
Figures are in DKK m.Source: Danish Ministry of Housing and Building

Contractors and not least design and consultant companies have also gained notable shares of export markets, especially in projects concerning energy and environmental solutions, areas in which Denmark has acted as a vanguard in the international community. And Danish architects are well-known for winning international architectural contests on the basis of a high artistic and professional performance level.

The development of the industry and the danish industrial house

After the second world war it became clear to Danish planners and politicians that a strongly rising demand for housing would occur in the 1950s and 1960s due to an increased rate of birth. At the same time an intensive migration of people from rural parts to urban parts of Denmark was in progress, making the needs for efficient production of housing in the cities even more urgent. Further to this a general rise in the level of economic activity was expected, thus increasing the demand for production facilities as well as buildings for commercial and administrative purposes.

The rising need for housing was not only expressed in terms of quantity but also as a demand for better quality, including for instance improved technical installations in the dwellings (central heating, bathroom and toilet etc.) as well as a better physical planning, which would allow tenants easy access to green areas and public leisure facilities.

The demand for quality and quantity called for a completely new approach in order to increase the output from the construction industry. A strong shortage of skilled labour could be anticipated, causing "bottlenecks" and sharp increases in wages and production costs; to prevent the consequences of this a more industrialised concept had to be developed and implemented. (Erhvervsfremmestyrelsen 1993) - this was the industrialised house.

The basic idea of this concept was to transfer a major part of the work, traditionally done on site by craftsmen, into factories as part of an industrialised production process. This could activate the large reserve of unskilled labourers and thus increase the output from the construction industry in accordance to the demands from the surrounding society. An equally important aspect of this development was furthermore to improve the working conditions of an industry characterised by heavy loads, severe noise and dust exposure as well as use of hazardous chemicals.

The take-off of this development was implemented in a rather dramatic manner by the Boligsministieriet (Danish Ministry of Housing and Building) in 1953. In a departmental order it was demanded that no more than 15% of the labour time for the production of a basic building structure should be consumed by skilled labour, if government finance was to be obtained. How this target was to be achieved by the actors of the construction process was however not specified - only the accumulated result of the condition was defined.

In reality by setting such financial restrictions the government created a new building market. Obviously this lead to change in a sector traditionally dominated by the architect and craftsmen as the key actors of the process. From that moment contractors gained importance in connection with the widespread introduction of the precast concrete technology in building. And the contractors were - not least for historically reasons - in an advantageous position to exploit this development. (Bonke & Jensen 1983)

In 1960 the next major step forward towards industrialisation was taken in another legislative action - the so-called *Montagecirkulære* (departmental order for the assembly of prefabricated building). In this the entire building process was described as part of an industrial production system in order to make further reductions in the consumption of labour and materials. Unlike previous attempts at industrialisation, planning and design was now defined to be an integral part of the industrialised construction process.

As part of the industrialisation strategy the Boligsministieriet had earlier introduced certain practices for the design of buildings. These practices included the *modulus-grid system* which made it possible to standardise dimensions of components for the building, and the system is thus to be considered an important precondition to the production of building materials on a large scale industrial basis.[2] Till then each window, door or cupboard had been produced individually by joiners in workshops or on site according to specification. The modulus-grid standard sizes made it far easier to apply industrialised methods and machinery to the production of all kinds of building components and materials.

One of many spin-off examples is illustrated by the emergence of modular kitchen industry, which transferred the production of kitchen units from the building site into the factory. The industry intensified this development by introducing sheet-based materials like melamine faced chipboard and high pressure laminates for tabletops. In similar ways having significant consequences for the traditional manufacturing of interior building parts the development of the paper faced gypsum panel constituted a new basis for improving site efficiency.

Equally as important, however, was the focus on the interface between building components, the intention being to make components multi-usable by setting up certain standards and guidelines for connecting details and joints between them. The combined efforts of these provisions made it possible for designers to make the desired variations when using standard components. This freedom covers both the technical and design aspects of the building. Furthermore these measures of co-ordination undoubtedly have contributed to the foundation of a quite strong building component industry in Denmark, giving many Danish producers a relative advantage in comparison to their competitors in other countries. Positive trends in export figures are continuously indicating the lucrative effects of this technology policy as discussed above.

However the most significant impact of the modulus-grid was on the production of precast concrete panels. From the 1960s this building system formed the core of the Danish construction industry. As indicated the development also placed the structural contractor in a key position, in many cases taking over responsibility for planning, design and construction. Several of the major general construction companies developed their own industrialised housing concept thus setting their fingerprints on the growth areas of

[2] The technical expertise and the most important lobbyist in this development was constituted by a rather small group of engineers, partly connected with the Technical University and centrally positioned in the engineers association. Some of these persons engaged in companies which became leading builders, in the following years, for instance P.E. Malmstrøm as consultant and Kerrn Jespersen as contractor in the company Jespersen and Son Ltd. (Jørgensen & Schou Pedersen 1983)

Danish cities. The systems were built either on an open or closed concept reflecting the adaptability to complementary products from third-party producers.

Historically these larger construction companies were accustomed to working with concrete from experience in civil engineering. They employed a large proportion of un-skilled labourers as part of their staff and had access to the necessary equipment for the assembly of the larger concrete panels. Furthermore the larger contracting companies had a background in a bigger production volume and hence it was obvious for the companies also to diversify into production of precast concrete panels.

PRODUCTIVITY

The consequences of this comprehensive technology policy of the Danish state were manifold. Concerning work productivity, not least, the effects were quite impressive. The amount of spent manpower producing one “standard” dwelling unit reduced sharply - from 1950 to 1980 by approximately 50 %. This development in fact enabled the building industry to supply the quantity of housing required and demanded by the surrounding society in the period.

The time spent on site reduced by approximately 65% while white collar office work more than doubled. The increased prefabrication also led to an absolute increase in time consumption in factories. However this increase was relatively minor mainly due to the fact that standard sizes for building components had been introduced, thus promoting investments in high automation technology. Also contributing to the increase in productivity was the appearance of lighter, advanced (hand)tools appropriate for the assembly and fitting of prefabricated materials on site. These tools became electrically or pneumatically powered making site work processes much faster and easier. The development in labour productivity (time consumption for production of one standard flat of 80 m²) from 1950 to 1980 is illustrated in figure 3.

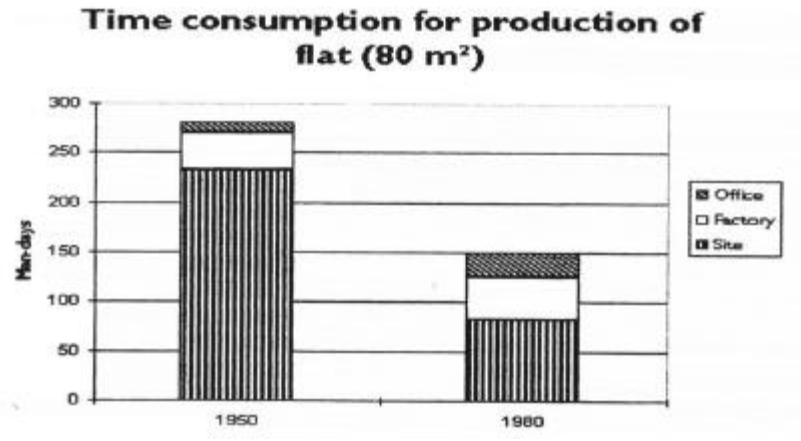


Figure 3 - Productivity Improvement in Housing Production
Source: Bonke & Jensen 1983

However appealing this development might seem it hides the fact that productivity has fallen since the change of concept from high-rise blocks of flats to high density low-rise housing in the 1970s. Recent surveys indicate that this development has meant a direct increase in the resource requirements measured in the period from the 1960s to the 1980s.

This development can be explained in several ways. One obvious explanation is the evident change in the product and the increased variation. Each project must be dealt with individually as opposed to being non-produced. The projects have also changed in the sense that they normally comprise 20 - 50 dwellings compared to the 500 - 1000 units often found in the projects during the 1960s. The immediate effect of this change is that the repetitive effect is reduced and at the same time the amount of planning spent on each unit in the project is relatively smaller compared to the larger projects. It is often the case on the smaller projects that planning is very scarce or completely absent. The contractors estimate that the relatively high, initial cost of planning cannot be recovered from a more efficient and smoother production.

Furthermore it appears to be of great importance that the Danish prefabrication concept, especially concerning the basic structure of the building, did not undergo radical adaptation in relation to the changes in architectural and functional design (low-density housing). Thus the prefabricated concrete panel continued to play a totally dominant role - and it still does. This obvious irreversibility of technology is furthermore confirmed by the surprising stability in the division of labour and functional relations between actors in the building process, despite any qualitative and quantitative market shifts in the thirty years.

During this period the stationary industry has been able to increase both productivity and variation in the product at the same time leaving the Danish construction industry in a weakened competitive position. In comparison, the building industry is characterised by a fragmented organisation custom built for each project. This means that communication and interaction between the parties is limited by the short history of collaboration and the random knowledge of the competence and capability among the partners in the project organisation. At the same time the quality of the product has been very heavily disputed due to the increased occurrence of building defects. The economic consequences of these problems are tremendous and if incorporated in an analysis of productivity, the increase in spending of resources would obviously tip the balance even further.

One of the more recent strategies to solve these problems and to regain some of the lost productivity has been to attempt a vertical integration of production by promoting the formation of consortia or fixed constellations between all the important parties (the design team, contractors and selected suppliers of materials) in the project organisation. It is the ambition that this new way of organising construction projects will not only mean reduction in the consumption of resources but it should also result in new products suited to modern concepts in terms of ecology, energy consumption, flexibility et cetera. This development is further discussed in the section entitled “Organisational developments”.

FLUCTUATIONS IN CONSTRUCTION OUTPUT

As a part of a market economy the construction industry follows the ups and downs of the surrounding national and international economy. Since building is still very labour intensive and has a high multiplier effect the industry also plays an important role in the Danish economy and it is very often used as a tool to regulate the level of activity. In figure 4, the fluctuations in the number of built housing units is illustrated. During the period 1960 to 1973 the output shows a continued growth doubling the output. In 1973 the first oil crisis triggered off a continuous reduction of construction output for the rest of the 1970s and into the early 1980s. In the mid 1980s the output increased slightly, among others due to a change of certain tax-rules. From late 1980s up till 1993 the activity level in new construction has generally been low, according to official studies not least reflecting the mature state of the building market.

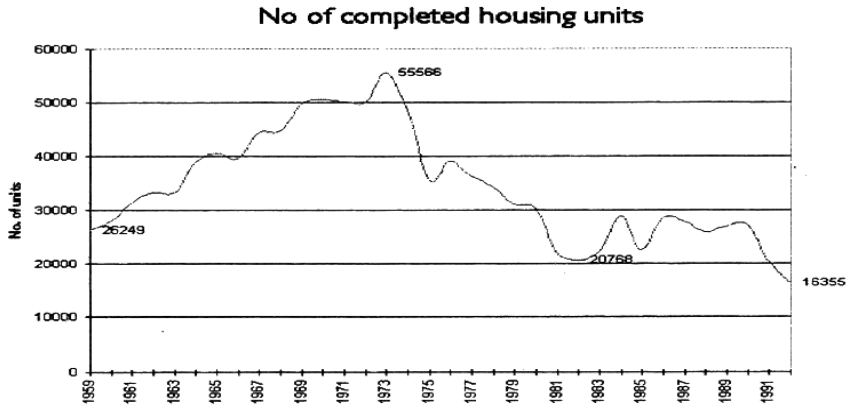


Figure 4 – Housing Output
source : Statistics Denmark

Thus the overall impression is the massive change in output from approximately 58.000 units per annum in 1973 to approximately 14.000 units in 1993. Compared to any other industry such fluctuations require an unprecedented flexibility of firms to adapt to new segments of the market as well as an ability to reduce cost. Indeed, the dramatic fall in output of new buildings does not reflect the true activity level in the building industry. Renovation and refurbishment activities have gradually gained importance in terms of employment and turnover for the companies in the building industry. The employment figures for new building and renovation activities in the latest 20 years are illustrated in figure 5. The significance of the renovation market has obviously led to an increase in knowledge and competence among all the parties in the construction process.

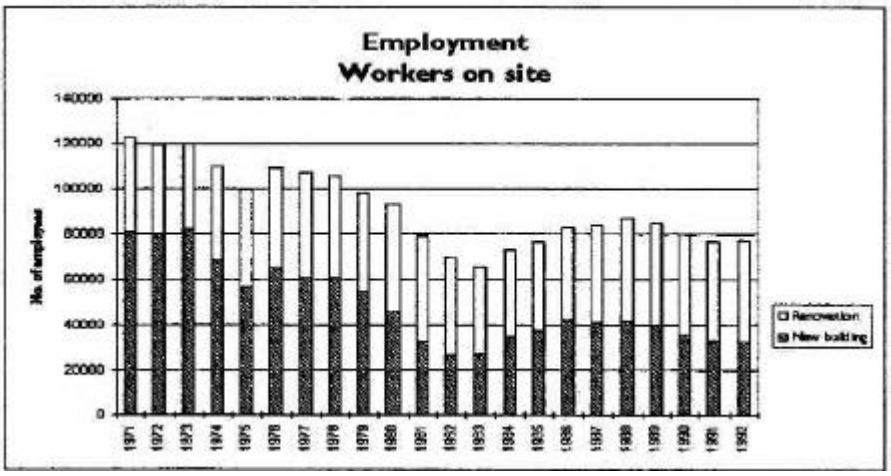


Figure 5 – Employment by Subsector

The market regulation methods of the Danish government take various forms. For instance, as mentioned above, the state has offered favourable conditions for reduction of interest rates for building finance in order to stimulate activities. Or it gives direct subsidies to tenants when renovating or improving their dwellings/houses. On the public spending side it is common to initiate large infrastructure projects in times of over-capacity in the construction industry. To prevent overheating in the economy the government typically tries to reduce the level of activity in construction by making it financially less favourable to build and own houses and by postponing larger investments in civil works. Another more practical method of levelling activities is to move public projects to winter periods, when building activity is normally lower due to weather

conditions. The Boligministeriet has been very active in promoting incentives for higher activity through the cold period of the year by developing methods and techniques for construction during wintertime.

QUALITY MANAGEMENT

The strongly rising number of defects in buildings of only 15 - 25 years age naturally led to an increased focus on the measures being taken to assure a sufficient level of quality in construction. During the early 1980s extensive studies revealed both basic technical faults as well as severe managerial malfunctions. This led to a combined effort to establish formal procedures to improve the quality of the industry's output. The process is known as *Kvalitetssikringsreformen* (The Quality Assurance and Liability Reform), whichwas put into force by the Boligministeriet in 1986 as a departmental order.

Figure 6 illustrates the basic idea behind the reform, which is to urge the actors of the building process to identify the optimal balance between the total cost for the project, the management cost and the cost of correcting defects. It is widely accepted that the construction process during the previous period had developed into a position far from this point of cost optimisation. The reform applied to all government financed building activities but with the ambition that principles and concepts would also spread into private building activities as well as civil engineering projects. The *Kvalitetssikringsreformen* is considered as one of the most thorough organisational and managerial state induced changes affecting the working practices of an industry, which is characterised by smaller companies in constantly changing organisational constellations and locations. The reform has been included in the *Almindelige betingelser for arbejder og leverancer i bygge- og anlægsvirksomhed - AB 92* (General Conditions for Building Works). The reform consists of several elements involving the whole process including suppliers of building materials as well as the end users of the buildings. The main elements were:

- new procedures for design and execution
- formal procedures for the documentation of quality in design and execution
- unification of periods of liability for all parties involved in the project
- the establishment of *Byggeskadefonden* (The Building Defects Fund)
- manuals for care and maintenance
- 5-years inspection

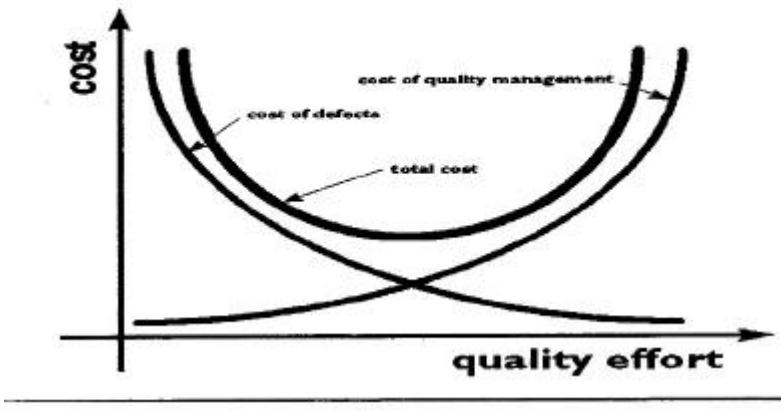


Figure 6 – The Philosophy behind the Quality Reform

During the design phase additional activities have been introduced emphasising the need for both internal and external design reviews. The idea is to minimise design faults as well as activating the production experience traditionally available at contracting level as early as possible.

Formal procedures for the documentation of the level of quality were introduced as being an integral part of the construction process. Each party has to document its conformity

with the specified level of quality. The documentation obtained in this process is finally included in the material handed over to the client at the end of the construction period. This particular part of the reform has - due to the often large amounts of paper - been considered time consuming and difficult to handle for a great number of the smaller craftsman-like companies.

Trials in the early 1980s showed that the placing of legal responsibility and the obtaining of money to recover the damage proved to be a very lengthy and complex process, often leading to payments only covering a small part of the damages encountered. A major problem in the legal actions was the variations in the periods of responsibility between suppliers, designers and contractors. Ranging from 1 year to 20 years, the involved parties had diverging interests in quality aspects of the finished building. With the proposed unifying of responsibility periods the parties' attitude towards obtaining the presumed quality became at least legally equalised.

Based on the above mentioned experiences with the inadequate level of quality in buildings 15-25 years old the Boligministeriet decided to establish an independent non-profit insurance institution called the *Byggeskadefonden*. The fund works as an insurance pool against defects for all state financed or subsidised building activities. As a part of the construction budget a premium of 1% is paid into the fund, and if defects are discovered within the first 20 years of the building's lifetime the repair costs will be covered by the fund. The fund conducts the 5-year inspections for the insured buildings and the cost of the inspection amounts to half of the paid premium with the other half expected to cover the repairs. A secondary but crucial objective of the fund is to obtain, store and communicate knowledge about building defects in a structured manner to the actors of the sector.

The fund, however, does not work as a "carte blanche" for building firms, because the fund will legally reclaim its costs by placing responsibility with one or more of the parties involved in the construction of the building. The important difference to the previous situation is that the repair works can be executed immediately after discovering the damage and that the burden of processing legal claims have been released from the tenants' and owners' organisations. In connection with the obligatory 5-year inspection of buildings it is furthermore to be assessed, whether the necessary precautions in the field of care and maintenance have been taken. Manuals covering expected operations in care and maintenance are an integral part of the documentation handed over to the client at the end of the building period.

On a company level the ISO-9000 standard has been introduced as a tool to manage the formalised quality procedures. This standard has been implemented in particular among some of the larger general contractors and producers of building materials. The smaller specialised contractors, however, typically use customised quality management procedures developed by their employers organisations. This also covers the situation for the architects and engineers using standardised quality management procedures.

ORGANISATIONAL DEVELOPMENTS

As earlier indicated the current predominant trend in organisational development highlights a vertical integration of the different actors and their functions in the construction process. This vertical integration and the expansion of cooperation is seen as a necessary means to achieve better quality and productivity in a production process, which traditionally is extremely atomised between the large number of different parties.

Many years of practical experience and extensive organisational research have established knowledge about the implications of the constantly changing organisational constellations and physical surroundings, which constitute the major barriers for further improvement in quality and productivity. During the still shorter action period of construction projects the involved parties do not have the necessary time and confidence to develop long term relations. On the contrary, diverging interests often dominate the interrelations. Obviously this causes problems in respect to achieving the intended quality and leads to overrun of time and costs. In order to reduce the problem of potential counteraction between the involved parties new constellations in the organisation of the

process are being investigated. The main issue of such changes is to identify an appropriate distribution of functions and responsibility and to anchor this in a precise but flexible information structure.

In a recent contest for an organisational development project programme, *Proces- og Produktudvikling i Byggeriet* (Process and Product Development in Construction), only consortia representing the whole value adding chain were invited to tender. This stands in clear contrast to the traditional set-up, where the contractor is holding the sole obligation for the fulfilment of the contract. In the consortium environment, the design process is undertaken not only by the traditional designers, but also contractors and suppliers participate actively with inputs. The computer integration between all parties must be extensive, preferably with all data concerning the project stored in a commonly accessible database. This database then serves as vital mean of communication, holding all information for the approval by the relevant authorities as well as detailed planning of the construction process including the logistics. Finally the database also serves as basis for the management of care and maintenance operations necessary during the lifetime of the building.

An important aspect of this organisational and environmental change created in the consortia is the improved conditions for development of the end-product. It is believed that the active participation of the producers/suppliers of building materials will influence the product in a very positive way. The producers have in depth knowledge of their materials, which - if handled appropriately - leads to cost reductions in terms of fewer defects as well as a better utilisation of the material. As an indication on the innovative potential this new concept, one of the winning consortia in the contest launched a proposal for a multi-storey wooden-based housing project (including all load bearing structures). This is rather unique in a Danish context, since concrete and brick based building techniques have been totally dominant for generations.

THE EXTERNAL FRAMEWORK OF CONSTRUCTION PROJECTS

The acts and regulations for the construction industry are mainly submitted by the Boligministeriet but other ministries cover the more specific aspects of the industry.

The Boligministeriet

The Boligministeriet is obviously centrally placed in relation to the industry. The general political aim of the ministry is to secure well equipped and adequate housing. The policy is also seen as an integrated instrument in the political monitoring and control of the general level of economic activity in the society in respect to employment, inflation, fixing of wage rates and the like. The Boligministeriet covers the following main aspects of the construction industry:

- building procurement
- estates management for certain types of public buildings
- facilities management
- quality of the construction works
- quality assurance and liability
- *Byggeskadefonden*
- general development of the construction industry
- tender rules
- tender procedures tender procedures in accordance to European Union regulation
- pricing and duration of contracts
- seasonal fluctuations
- acts for regulating the activities of architects and engineers

With the rapid increase in the output of new industrialised homes after the second world war, the market has gradually come nearer to a point of saturation and a reduced importance of new building activities. This lower level of activity has tended to reduce the allocation of funding for research and development activities in new building. On the other hand, the simultaneous shift towards more renovation activities has brought along R & D programmes on the efficiency of the renovation process, just as the general focus on

environmental matters has led to substantial savings on consumption of electricity, heating and water in existing buildings.

Another important development is recently represented by the decentralisation of the monitoring and controls concerning the activities in the social housing sector. Now the local authorities are involved to a much larger extent than earlier. Inevitably the ministry has been heavily engaged in the harmonisation process towards European market integration. Harmonisation has involved areas like tender procedures, public procurement, technical standards on design as well as on building materials. From setting the pace solely in the technological development of the construction industry the ministry now plays this role in co-operation with departments of other ministries. As indicated above such ministries are now partly covering for instance energy consumption and other central environmental areas related to the construction of buildings. Among policy makers it is considered a development issue to solve the productivity stagnation in new building. At the same time it is an agreed strategy to improve the efficiency of the renovation process by applying industrialised production concepts.

Bygningsreglement

A central tool in the ministry's action in relation to the industry is *Byggeloven* (The Building Act) and the attached *Bygningsreglement* (Building Regulation). The *Bygningsreglement* is in force nation-wide, thus enabling companies in the industry to work across the country. This is an important aspect in the perspective of developing new building concepts as well as creating one large market for components with maximum competition.

The *Bygningsreglement* applies to all building activities in Denmark except for works on smaller buildings (consisting of only one dwelling or semi-detached house). For this type of work there is a separate set of regulations, which permits the owner to do non-critical types of works without having to go through a lengthy process of getting approval from the authorities.

The overall aim of the *Bygningsreglement* is to ensure buildings of a certain standard in respect to fire resistance, general health and safety aspects and, of course, the basic quality of the buildings. The aim is also to avoid waste of energy and materials thus promoting environmentally friendly ways of constructing. Thirdly the *Bygningsreglement* deals with the interaction of new buildings towards the existing, surrounding buildings.

To a very large extend the *Bygningsreglement* is based on functional demands rather than specified details for the actual construction. This leaves a great amount of freedom of method for designers as well as for contractors to fulfil the functional demands specified in the *Bygningsreglement*. This gives room and initiative for continuous development in building technology.

The latest revisions of the *Bygningsreglement* were issued during spring 1995 stating the most recent level of performance for modern buildings. As earlier indicated the trend is focusing on energy consumption with a specified reduction of 25% compared to the previous standards. Another item of particular interest is the indoor climate of buildings, making the exposure to hazardous evaporation from building materials as low as possible. Attention is paid to chemical compounds like formaldehyde and to fibres from asbestos and mineralwool.

The *Bygningsreglement* is almost entirely based on functional demands as opposed to detailed technical requirements. This leaves a large degree of freedom in the design chosen by the architects and the consulting engineers and to some degree also a freedom for the contractors' selection of materials and methods.

Building Permit

Prior to commencing construction works the client is under an obligation to notify the local authorities by submitting a written application, which describes the purpose of the building, the structural design, the site location etc. On this basis a building permit can be

obtained. The local authorities have full responsibility for assuring that the requirements of the *Bygningsreglement* are met.

It is the client's responsibility, however, to fulfil all legal requirements. If construction work has not commenced within one year from the issue of the permit, it is automatically cancelled. When construction works are finished the building cannot be taken into use before inspection and approval by the public authorities has been completed.

For minor works like small extensions to single-family houses or individual renovation of flats it is considered sufficient to notify the local authorities in advance. The authorities must react against the plans within a certain time limit if they intend to stop the project.

General Conditions

An important tool in the regulation of the activities in the industry the legal conditions are agreed among the parties as being general to all construction activity in Denmark. They are articulated in *Almindelige betingelser for arbejder og leverancer i bygge- og anlægsvirksomhed - AB 92* (General Conditions for Works and Supplies for Building and Civil Engineering Works). These conditions represent a substantial part of all contracts for construction works regulating the relations between the parties (client, contractor and suppliers).

AB 92 includes items like:

- insurance and provision of security
- the works
- payments
- time extension and delay
- transfer of works
- defects
- and 5 years inspection
- cancellation of work
- disputes/arbitration

The AB 92 is complemented by *Almindelige Bestemmelser for teknisk Rådgivning og bistand - ABR 89* (General Conditions for Consulting Services), which regulate the relation between client and designer/consultant. Furthermore the Ministry of Building and Housing has recently issued a specially adapted set of general conditions, *Almindelige Betingelser for Totalentreprise ABT 93,* which covers the special type of contractual relations in design and build contracts, where design is an integrated part of the works to be supplied. Most trade organisations and associations have issued standard amendments to the general conditions taking into account the more detailed and specific aspects of their respective roles in the construction process.

Other Ministries

In addition to the Boligministeriet other ministries cover specific aspects of relevance to the construction industry:

- *Erhvervsministeriet* (Ministry of Business and Industry) covers the business or commercially orientated aspects of the industry, the business development of the industry and the technological service infrastructure.
- Environment) specifies guidelines for the consumption of Energy within the construction process as well as in the buildings. It also handles the environmental impact of construction activities and it is in this connection occupied with recycling activities and the introduction of environmentally friendly technology.
- *Undervisningsministeriet* (Ministry of Education) handles qualification matters related to the technical educations in the construction industry as well as matters on basic research conducted within the framework of the teaching institutions. For historic reasons this ministry runs a special department, *Byggedirektoratet* (The Building Directorate), acting as the client/consultant on a considerable number of large public building projects. This function dates back to the 1960s and 1970s when the ministry erected many schools and other educational institutions thus achieving great experience as client.

- *Arbejdsministeriet* (Ministry of Labour) handles questions specific to the labour market, educational matters directly linked to the labour market and health and safety aspects.
- *Kulturministeriet* (Ministry of Culture) deals with the education and training of architects.
- *Socialministeriet* (Ministry of Social Affairs) has developed special housing concepts for elderly and disabled persons. Recently the ministry has furthermore introduced turn-key low-cost housing projects designed for foreign markets.

The Working Environment Act and Regulations

In an international perspective Denmark has been pioneering strategies for health and safety improvements in construction. As a general rule such improvements are obtained from combined efforts of authorities, employers and employees and their respective organisations. *Arbejdsmiljøloven* (The Danish Working Environment Act) is a framework containing only a few detailed regulations. Within this overall framework, detailed rules are formulated by way of administrative regulations, issued by the Ministry of Labour or *Arbejdstilsynet* (The Working Environment Service - WES). The Danish rules are regularly amended to comply with the various regulations and directives adopted by the EC.

The Danish Working Environment Act has the following preamble:

> "The provisions of this Act shall have effect with a view to creating:
>
> - a safe and healthy working environment at all times adapted to the technical and social developments of society;
> - a basis which enables the enterprises to resolve questions regarding health and safety under guidance and control by the social partners and the Danish WES"

Most of the regulations deal with technical matters. As a fundamental principle in all regulations the parties are obliged always to choose the best methods of procurement, materials, machinery etc. in order to minimise the risk to health and safety.

From a managerial point of view rules of special interest are those concerning the organisational set-up and the planning. Some of these rules are explained below. For every building project exceeding a certain size or duration a detailed security plan - *Sikkerhedsplan* - must be made in order to ensure that the works can be undertaken in proper manner and in conformity with the legislation. The plan also secures the appropriate co-ordination of the safety work among the contractors.

Some of the basic elements of the plan are:

- the organisation of the building site
- a scheme showing the general lay-out of the site
- a time schedule
- information on the establishment of safety precautions and welfare facilities
- the identification of any high risk working areas and the necessary precautions

In general, the plan must contain information on all operations affecting health or safety by specifying the duration, place and the person or company responsible for each operation in question.

Formally, the client has certain responsibilities in respect to the safety work. However in accordance with the rules in the specific regulations, the normal procedure is that the client transfers all the above mentioned legal duties concerning health and safety to either the consultant or the main contractor. Prior to start-up of work on site it is compulsory to report the forthcoming construction activity to the WES and to make sure that the above mentioned written plan for health and safety concerning the actual construction site has been prepared.

The designer is responsible for ensuring that the work on site can be carried out in a safe and healthy manner. Some of the factors, and their consequences for the working conditions on site, which the designer has to consider are:

- selection of design in view of constructability (architect and consultant engineer)

- sequence of construction
- procurement methods
- selection of materials and equipment

It is also the responsibility of the designer to provide a plan explaining how the work can be carried out in a safe manner providing the necessary time in the different stages of the construction process.

During the period of work on site matters of health and safety are dealt with by the safety organisation. Apart from the client the safety organisation includes - for each contractor - one member elected by the employees and one member representing the employer. It is the responsibility of the client to ensure regular meetings (at least once a month) in the safety organisation. During these meetings the health and safety plan should be updated.

The contractor is responsible for the health and safety of his own employees. This responsibility includes instruction of the employees, controlling that instructions as well as the general provisions of the working environment act are met, co-operation with other contractors on matters of health and safety etc. Furthermore, the contractor is responsible for the delegation and co-ordination of safety work between all sub-contractors he may employ as a part of his works package.

Contractors

In this perspective it has proven vital that all different trades have been active in establishing relevant codes of practice for carrying out construction works. These codes of practice have been included as an important integral part of the *Kvalitetssikringsreformen* initiated by the Boligministeriet in the mid 1980s.

In the case of aspects related to the tenants' immediate health and safety when utilising the building there is a demand for a formalisation of these codes of practice by imposing the need for authorisations of companies within certain trades (e.g. companies fitting electrical installations or companies doing plumbing works). Lack of conformance to the code of practice or regulation leads to loss of authorisation thus excluding the company from future works.

Building Materials and Components

When the architect specifies materials for a project the general procedure is to make a reference to the relevant system of certification thus ensuring an adequate quality without determining a specific material or producer. In theory this leads to the strongest competition giving the lowest prices on a specified level of quality.

All major categories of materials are in some way or another covered by a controlling arrangement. These controls are often conducted by the Technological Institutes, which are internationally recognised and independent of producers' interests. Within the European Union several systems of internationally ratified certification has emerged. These systems cover not only the material but also the quality control schemes associated with the production.

The latter circumstance in fact provides producers with an immediate and easy access to foreign export markets without having to do time- and money consuming new certifications for a new product under consideration for a particular market. An example of this is the certification of prefabricated concrete units giving producers all across the member states in the European Union access to an entire unified European market.

The emergence of certification schemes is often the result of a reflection upon manifest building defects. With the strong repetition of details in industrialised building projects repairs have often been extremely costly. A classic example of this is represented by the industrialised production of windows and exterior doors now being manufactured according to the specification of *Dansk Vindues Kontrol - DVK* (Danish Window Control). This specification sets a minimum standard for all basic materials in the window (wood, glass, coating material, glue, hinges etc.) The manufacturers have established their own control organisation managed by the independent Technological Institute.

Furthermore the producers of precast concrete elements and ready mix concrete manufacture their products according to a basic recipe, *Basisbetonbeskrivelsen* (Basic Concrete Specification for Building Structures), established by the Boligministeriet. This should be seen as a response to defects caused by numerous cases of poor quality not only in works done on site but also in the quality of precast concrete panels or ready-mix concrete deliveries.

From this it appears that one type of control covering all relevant aspects is related to each type of material. For the architect and engineer this principle is easy and reliable since he has only to refer to one kind of certification. Recently, however, a system for indoor climate certification of building materials in general has been introduced. This reflects the increased focusing on overall environmental matters.

In an international perspective, the concept of certification of materials has proven very important. Danish building material firms for instance have achieved high competitiveness since foreign producers, having easy access to the Danish market, apply constant pressure onto the domestic producers. And this ability to compete and perform to internationally accepted standards has proven it easier for the best firms to market their products in foreign countries, giving the building materials industry as such a quite strong position.

EDUCATION AND TRAINING

The education system related to the construction industry consists of the following main elements:

- the institutions for higher education
- the technical schools
- the schools for labour market training
- in service-training

Generally the education system in Denmark is only indirectly linked to the companies in the industry. This field is mostly considered a public task for the specialised training/education institutions, and in-house education in companies is thus rather scarce. In cases of urgent domestic training needs these are very often targeted towards specific techniques or equipment and done in a close co-operation between either the technical schools or the institutions for labour market training.

The institutions of higher education are of course educating the white-collar workers of the industry, such as architects, engineers and land register surveyors. The training of engineers at these institutions is now two-phased - on a bachelor level and master level. Most other educations are to a master level. The duration of education to masters level is normally five years while studies to a bachelors level normally last 3½ years. In Denmark there are two universities for the training of engineers to a masters level and two schools of fine arts for the education of architects to a masters level.

Previously it was quite common among tradesmen to do further studies in either architecture or engineering as a part of their professional career. This educational sequence of course resulted in technicians with a practice-based understanding of the actual construction process and the techniques involved. However in recent years most architects and engineers have solely an academic background reflecting the fact that scientifically-based management methods and control forms have become very important.

Between the institutions of higher education and the secondary schools an intermediate level of education is present. At these schools, technicians are trained to two different levels for a 3 year period and for a 1½ year period. These schools do not demand pre-entry qualifications at grammar school level which is the case with the institutions of higher educations.

The technical schools educate and train white as well as blue collar workers. For young people going for an apprenticeship the training is periodically divided between a technical school and a company. This division secures the attention to important basic skills inside

the framework of the technical school as well as to the more specialised skills, developed during the (site-oriented) company training.

Normal duration of an apprenticeship is 3 - 3½ years including approximately a 1½ year stay at the technical school. The trades covered by the technical schools are:

- carpentry
- plumbing
- electrical works
- brick laying
- painting

This structure reflects the traditional trade organisation found on building sites.

White collar workers trained at the technical schools are, for instance, certain types of technicians/engineers doing specialised tasks (like technical drawing) either at design companies or on site. This training normally takes 3 to 3½ years and has a rather practical content not requiring an academic background.

Looking at the labour market training the general intention is to obtain a certain level of specialised skills among the general labour force. In the boom-period during the 1950s and the 1960s this training acted as a policy means for the transfer of surplus agricultural labour in rural areas to construction activities in urban areas. Besides the social aspects the aim of this conversion was not least to avoid bottlenecks leading to booming wages and soaring prices in construction. The training normally consisted of shorter specialised courses enabling the workforce to fluctuate between training and work in the industry. This has obvious advantages in an industry with strong seasonal fluctuations. The training offered can be sequenced to achieve a larger degree of specialisation.

This policy has been continued by the introduction of a more formalised training schedule offered to the non and semi-skilled part of the labour force normally not obtaining formal qualifications. It is targeted towards the processes normally associated with the ground and the basic structures of the building and it is comparable to the system of apprenticeship known from the traditional trades. This means that the training includes work on site as well as training in the technical schools. The training has a variable duration of maximum four years depending on the experience of the student.

In-service training for blue and white collar workers is divided into a dual system. For the latter with higher education, in-service training is normally managed by commercial companies specialised in this type of training. An example of such an in-service training sequence is the training for building economist. This is a course scheduled for a duration of 240 hours aimed at architects and engineers upgrading their qualifications in the aspect of financial management of the building process. Normally in-service training does not carry any type of official recognition or approval.

In-service training for the blue-collars and groups of technicians normally takes place at the technical schools on a shorter term basis often in periods of lower activity. To ease the alternation between work and training the labour market schools have schemed their courses in rather flexible, modular sequences. Having participated in this type of in-service training the worker achieves the formal recognition of his new level of qualification. In-service training is financed by a gross tax of 5 % paid by Danish taxpayers. This reflects the emphasis laid by the state on educational matters as a tool for the constant upgrade of qualifications within the workforce.

LABOUR MARKET RELATIONS

The labour market in Denmark is generally considered very well organised. Both employees and employers have established strong organisations taking care of the interests of their members. The level of organisation membership exceeds 90 %.

From a rather fragmented structure the tendency in recent years developed towards centralisation of the labour market organisations. The tradesmen and semi-skilled workers are traditionally organised by craft in trade unions, which cover questions of for instance wages, working conditions and broader political aspects of the labour relations. The unions also run the unemployment insurance system. This system is partly financed

by the employee - the major cost, however, is taken by the state. A group of important employee trade unions have recently formed *BAT-kartellet* (unified cartel of construction workers) organising skilled tradesmen as well as semi-skilled workers.

The white collar workers of the industry are correspondingly organised in their own unions (as architects or engineers etc.). However, for these professions, other types of association dealing jointly with the aspects of employment and general professional matters (in-service training, international developments etc) also play an important role. For historical reasons, both employees and employers (as individuals) become members of these organisations. To reduce the obvious potential for internal conflicts specific matters are typically dealt with inside the frameworks of sub-groupings of the organisations.

On the employers side the smaller specialist contractors have established the organisation *Byggeriets Arbejdsgivere - BYG* (The Danish Master Building Organisation) covering most of the traditional tradesman-based companies. The general contractors, however hold their own organisation *Entreprenørforeningen* (The Danish Contractors' Association). This division underlines the somewhat different scope of interests of these companies compared to the rest of the employers in the construction industry. Recently the employers have engaged in a round-table organisation named *Byggeriets Firkant* covering general as well as specialist contractors. This organisation deals with all aspects of the construction industry as seen from the employers point of view in relation to the general political level as well as more building related areas like contractual amendments, fixing of wage rates and the like.

Consultants are organised in separate associations for architects (PAR) and engineers (FRI). They serve as employers associations dealing with general political questions, matters related to the employees as well as professional matters on a company level related to other parties in the building process. As an example of their activities these two organisations have elaborated detailed specifications of the activities to be conducted by the different parties in the building process. Furthermore the architects and engineers have formed a joint organisation, *AI-rådet* (council of architects & engineers) dealing with interface matters of the two parties and representing the architects and engineers in international matters.

The producers of building materials are organised in *Dansk Industri* (Confederation of Danish Industries) in which they have their own section dealing with matters specific to the production of materials and components for the construction industry.

The traditional weighty fields of activity for the organisations on both sides are questions related to agreements on wages, working conditions and questions related to education and training. This includes all topics related to the Industrial Relations Court where disputes concerning wages and working conditions are treated, if a solution cannot be reached at an organisational level. The organisations have a long record of exerting influence on the political decision level in Denmark. In reverse, this strategy confirms the role of the construction industry as a much used tool in the regulation of the overall national economy during the last 50 years.

The recent development of stronger and more comprehensive horizontal organisations to some extent implies uniting parties across the traditional boundaries of the production process. In a wider perspective this might hopefully soften the areas of conflict between the different trades and parties and also reintroduce benefits of synergy in the modern fragmented building process.

AGREEMENTS ON FEES AND WAGES

In principle, the fixing of labour wages in Danish construction companies is based on the supply and demand situation on the labour market. This means no upper limit to the wages, whereas the minimum level is negotiated by the parties' organisations.

The wages for blue collar workers are either based on an hourly payment or on a *contract rate* (piece rate /"lump sum"). The wages are fixed as a result of a partly central negotiation process between the employer and employee organisations and a partly local

agreement directly between the construction company and the site workers (typically organised in gangs). The local agreement is determined in relation to specifications for the particular operation to be undertaken (see also Bonke & Gø tz 1982). Thus the employer and employee organisations set the framework within which the local negotiations on wages can be conducted. This payment by performance system combines the minimum hourly rate with a catalogue of prices listed for each operation.

A contract rate agreement could be considered an important tool for control and motivation, giving the construction worker an incentive to plan his own work and performance in order to maximise his payments. In this way a substantial part of the responsibility for an effective work planning is in fact transferred from the management level to the operation level. On the other hand payment by the piece-agreements are not applicable to all types of operations. Especially some types of renovation works are characterised by high degree of technical uncertainty, which makes it impossible to fix unit prices for each type of operation. In such cases wages are determined on a pure hourly basis.

Prior to the beginning of a particular piece of work the payment is agreed between the employer and the leader of the gang. As indicated the price book forms the basis for this negotiation but the agreement also includes specific conditions under which the work is done as well as the general supply and demand situation on regional labour market.

Traditionally the relationship between the employer and his employees has been quite loose allowing labour to migrate between different companies. This gives the possibility to the worker of changing company if better salaries are offered typically in periods of shortage in supply of labour. On the other hand the employer quite easily can lay off the workforce in times of low activity.

MANAGING THE BUILDING PROCESS

The construction of buildings traditionally involves a considerable number of different parties. The process is unique in the sense that it takes place in an environment where constellations between people, companies and public authorities constantly change. Correspondingly the physical conditions are always changing since construction never takes place at the same location. Consequently management of the building process must vary depending on the specific type of the project as well as the conditions (duration, budget etc.) under which the project takes place. Thus management arrangements differ considerably from project to project, but important changes can also be observed from a historical perspective as a result of the major alterations in the construction industry over the last five decades.

When producing buildings under market economy conditions it is vital to understand the participants' different and to some extent contrasting objectives. The main formal objective for all involved parties will be to supply the client with a product as specified in the mutual agreement (the contract). However this transaction will be executed at the minimum expense in order to maximise the generation of profit. At the same time the client's subjective interest is to maximise the quality of the project within the agreed economic frame (Bang 1992).

Traditionally in the Danish building process design and the construction are two rather separated phases. This fundamental characteristic, however, has gradually been revised and a broader variety of modern organisational arrangements and tender methods are now influencing the distribution of work functions, for instance design done by the design team in relation to design integrated in the contractors work or in the material deliveries.

In the traditional understanding the architect is considered as being the "client's man", impartial in respect to contractors and suppliers involved in the construction process. Within this concept the architect is addressing the overall function and the human, the technical and the financial matters of the building in a combined balance. In this process the details in the technical, aesthetic and legal fields are important but the overall perspective prevails. The contractor carries out the actual work in connection with the materialisation of the project.

A recent issue of functional restructuring has been the quality aspects of the end-product. The reinforced focusing on product properties has in fact influenced the process development at all levels. Thus the effort to improve product performance has had a primary impact on the formal level of the process often within the context of ISO 9000 inspired quality management approaches. This formalisation has resulted in changes to the informal relations between the parties normally forming the vital part of the building "universe" in Denmark.

In the same manner "green thinking" will influence the construction process in the years to come. Sustainability concepts will change the process itself by minimising the consumption of energy and other resources, but it will also have a great impact on the product characteristics through the introduction of new materials, new insulation standards, recirculating wastewater units, improved electrical devices etc. This in fact implies a radically revised approach enforced on design teams and contractors, since a great number of existing building materials and methods will be regarded as obsolete in the future. Taken to the full impact ecology will probably be a factor as important to the Danish construction industry as industrialisation was throughout thirty years post-war period. (Egebjerg & Falk 1996)

For larger public building projects (total value of the project more than 5 million ECU or the value of the design-fee is more than 200,000 ECU) new European Union tender procedures will influence the traditional boundaries between architect and engineer in the design team. The political intentions behind these new tender procedures are to increase international competition on larger and more specialised building projects.

The legislation on open tenders on design of buildings has entailed an integration of the tasks normally separated between architects and engineers. When previously the client selected his designer on the basis of subjective criteria, he now has to engage with, in principle, an unknown design team. This again has caused changes in the management set up procedures, because of the client's new need for risk reduction in relation to potential design team conflicts and in order to clarify questions of responsibility.

Information technology is also having radically increasing importance as a major influential factor on the future building process management. In the design work the use of computers is widespread. However, the ultimate integration of computerised communication between the crucial parties in the building process (client, designer, supplier, contractor) still remains to be demonstrated successfully. To improve the utilisation of IT as well as the implementation of the other characteristic developments mentioned above several state subsidised experimental programmes have been introduced to the construction industry, all having an increased contractual and co-operative integration of the parties on the agenda.

PHASES IN THE CONSTRUCTION PROCESS

The sequential division of the building process is defined in *Fasemodellen* (the phase model). The model was introduced to the Danish construction industry as an element of the industrialisation process during the post-war period. Basically the model operates with a distribution of work functions as found in the conventional industry. Each party involved in the process performs only specialised work based on specialist skills, methods and tools. Correspondingly all activities in the process are managed tightly by specialist managers or consultants attached to the project organisation.

As underlined above this management aspect is very important, since the organisational set-up for the construction of any building or plant varies from project to project. And the "unique" set-up represents a crucial obstacle to the development of in-depth collaborative routines as well as long term informal relationships between the involved parties.

The Danish phase model divides the construction process into five major parts. In principle, the sequential build up of specifications during the design phase serves as basis for the decision making and actual construction. The five phases are:

- briefing
- proposal (concept and scheme design)

- detail design
- execution (construction)
- operation (facilities management)

These are presented in greater detail in figure 7.

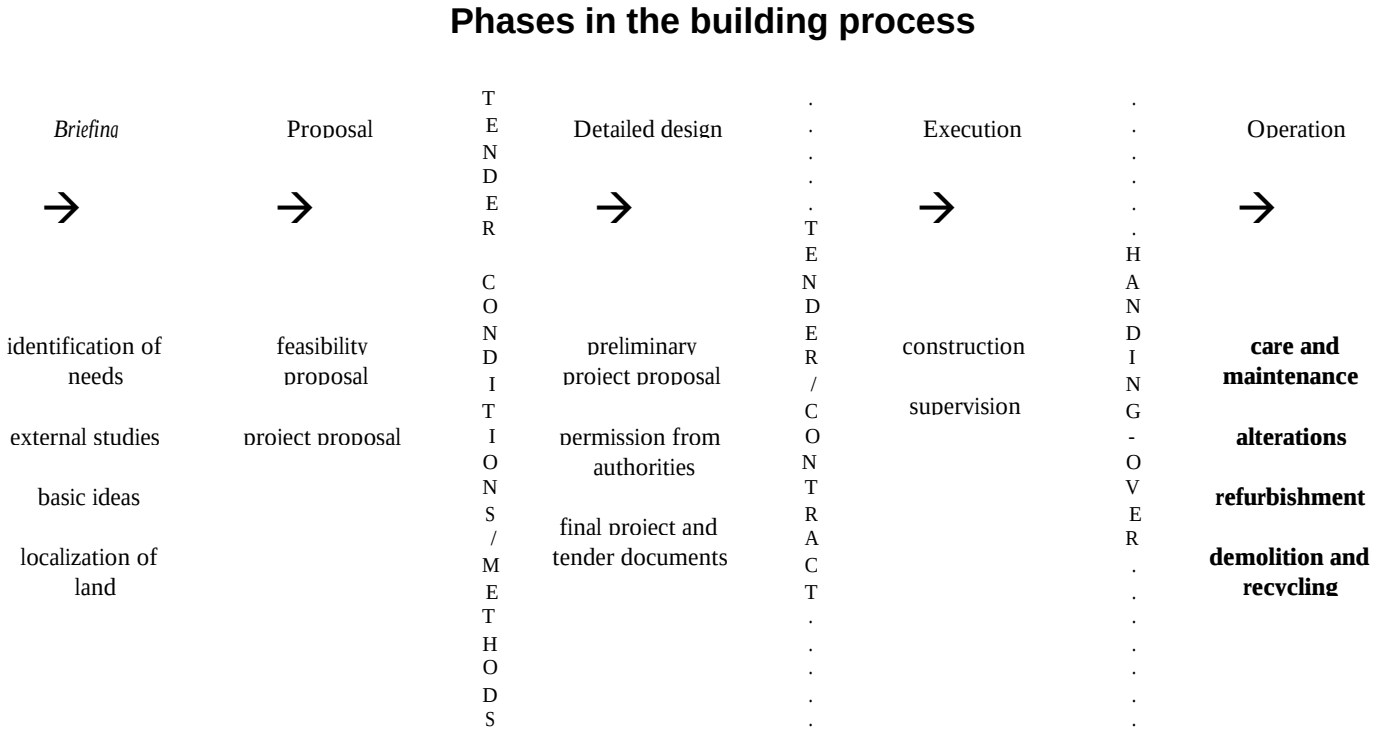


Figure 7 - The Phase Model

Briefing

The first step initiating construction is the identification of the need for a particular project to be constructed. The spectrum of market segments is manifold: a motorway easing transport of goods and commuting of people; plant facilities to adapt to new production technology; housing for the elderly due to demographic displacements; urban renewal as a measure towards social segmentation; not to mention the vast number of product varieties within these segments.

In the early stages the basic ideas in terms of functionality, aesthetics, and performance are expressed These ideas are often formulated in a dialogue between the *Bygherre* (client) and the *Arkitekt* (architect*)*. Depending on the organisational relationship and the nature of the project also the end-users can be involved even at this very early stage of the programming in order add in their requirements and experiences.The next task is to summarise the requirements in a structured manner avoiding direct contradiction in terms of feasibility, economy and legal matters. This also involves the identification of a potential piece of land on which the construction can take place.

Proposal Phase (Concept and Scheme Design)

This phase covers an analysis of the actual possibilities for a constructed product of the specified type on the available land; a division of the project into sections (or buildings). Alternatives in terms of shapes/geometry are investigated, and principles for the load bearing structures and installations are discussed. Environmental aspects of the project are taken into consideration and this leads to an overall clarified conception of the nature of the project.

The project is also interfaced with the local planning regulations made by regional and municipal authorities. If the projects deviates from the published plan for the area, the impact of the project is subjected to a formal hearing offering the inhabitants in the area the possibility to object against or reject the project completely. Depending on the strength of the reaction the project is either altered to suit the previously approved plan or the project is moved to another area.

The analysis materialises in a feasibility proposal, in which the basic layout of the project is determined together with the key figures on the economy and the superior time schedule for the construction project. The proposal serves as a basis for appropriation of the land, and also as a working basis for the further stages of the design of the project.

A proposal for the project is then carried out for the acceptance of the functional, economical and aesthetic solution. The budget is split into estimates for each section of the project. This proposal is followed by general conditions for the contract as well as a description. Finally in this stage a decision is taken on the method of tender and on the conditions, on which contractors are asked to tender.

Detailed Design

The *arkitekt og ingeniør* (design team) now works out a preliminary proposal and assures that approvals from relevant authorities are obtained. These approvals form part of the tender documents. For the actual tendering the designers carry out a final scheme design. This implies production of the drawings intended for use during tendering and production.

The detailed design also includes the tender documents forming the basis on which the tendering invitation is submitted to the contractors. The tender invitations will normally comprise:

- conditions for tendering
- tender form
- general conditions of contract
- special conditions of contract
- technical description and specification
- drawings

There is a broad variation in the level of detailing in the technical description and specification and in the drawings. This level depends mainly on the contractual model to be chosen for the project: at one extreme a full specification including a bill of quantities; at the other extreme a mere statement of the functional requirements and the economic frame, leaving the rest to the contractor. The detailed design is followed by the tender. The tender process is subject to the regulations set in the *Licitationsloven* (Act on Competitive Tenders). The scope of this act is to ensure free and open competition for building and civil engineering works but also to prevent the client from squeezing the contractors bid in the negotiations following the tender.

The act contains five major conditions:

- bids are invited from two or more parties
- bidding takes place at the same time and location
- bids are subject to equal conditions and information
- bids are in writing and they are binding
- bids are opened and announced in the presence of the bidders

Tenders can be open (i.e. publicly announced), or the client can decide to invite contractors for tendering. The open and public tender is assumed to produce the most competitive bids, since all interested contractors are bidding. On the other hand the client might then be lacking experience in relation to the contractors that are going to build his project. In cases of publicly subsidised building projects it is obligatory bring it into open, public tender. However some public building projects are based on a prequalification process of the bidding contractors. The latter methods can be considered as a hybrid of an invited tender process maintaining a high level of competition. Design and build contracts, however, are only partly subject to these conditions for competitive tenders,

since the requirement on equal conditions and information is not valid when each bidding contractor enters with its own project.

Larger public building projects and civil engineering works (value more than 5 million ECU) are subject to legislation under the European Union. This legislation has a similar scope as the *Licitationsloven* ensuring maximum competition between interested contractors from EU member states. Procedures for the announcement of invitation for tendering are explicitly described. The EU-directives have been incorporated in the relevant part of the Danish legislation.

In the invitation for tendering bids can be drawn up in the following general versions:

- fixed price contracts
- cost plus contracts

Fixed price contracts are either a lump sum for the works to be done or a unit price followed by a bill of quantities provided in the specifications for the project. In these cases explicit procedures are fixed to handle deviations from the original project, such as variations or fluctuations in the quantities. In the cost plus contract the price for the work to be done is calculated on the basis of consumed time, materials and plant.

Fixed price contracts are often used for reasons of security, since little or no variation from the price is expected after contract signing. A contract typically includes the following items:

- contract form (scope of works, the price, time of completion, payments, guarantee etc.)
- general conditions setting the relationship between the parties in matters of legal nature
- technical description defining the execution of the work and stating the make of building parts or quality of the materials
- the drawings

Execution

In this phase the project materialises. The organisational arrangement for the actual construction differs from project to project and is based on characteristics like type of client, technical complexity, aesthetic and functional requirements.

An important part of this phase is the supervision of the works. The primary scope of the supervision is to clarify whether the works carried out are performing to the agreed standards in the specifications and drawings. The supervision can be split divided into two parts:

- the client's supervision
- the contractor's supervision

The client has a strong and objective interest in making sure that the quality is in accordance to the agreement initially settled with the contractor prior to the commencement of the execution. The *Bygherrerådgiver/byggestyring* (construction manager) is responsible for this by appointing works inspectors responsible for certain parts of the building or certain operations. The approval of the works is often connected to the payment to the contractor.

The *Entreprenør* (contractor) also has a strong interest in making sure that the operations done are in accordance with the contract. The cost of correcting works of insufficient quality often exceeds the value of the works hence giving the contractor a direct financial objective to make it right the first time doing it. Furthermore the standard procedures for quality assurance instruct the contractor to control its own works during construction and to provide documentation of this control. This documentation is included in the final collection of documents, which is handed over to the client after completion of the building.

Facilities management

The phase during which the building is being used (consumed) has previously more or less been neglected by the main actors of the building process. However, in recent years

the focus on the period has increased, partly due to the implementation of the *Kvalitetssikringsreformen*, which formally binds all parties to a 5-year inspection of the building. This also includes elaboration of explicit plans for the care and maintenance of the building.

Another factor in relation to this shift of attitude is the recession experienced by the industry in the last decade. This situation forced many companies to focus on care and maintenance activities as a potential growing market segment, thus offering clients systematic services in these fields. To the construction industry a highly interesting perspective on integration in this phase lies in the obvious derived total economy considerations, illustrated, for instance, by the fact that the consumption of cost in the lifetime of a building or a plant can reach as far as the double or the triple of the initial investment.

Financing

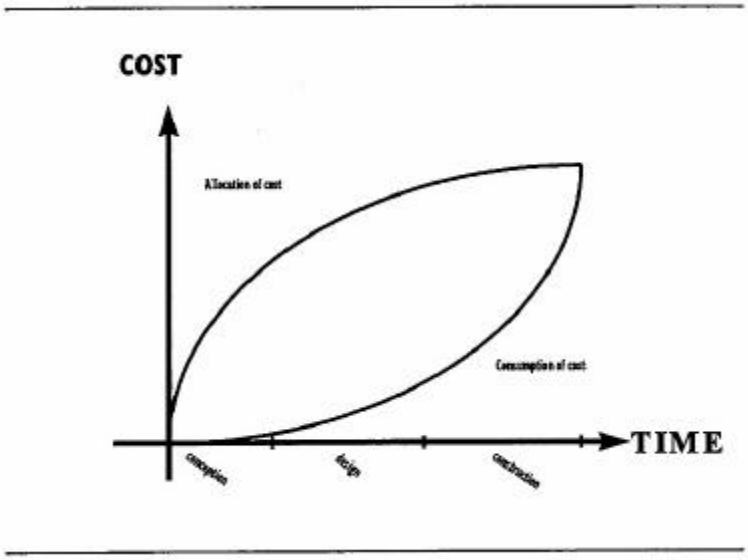
Project financing is obviously a basic task to be undertaken across all the above mentioned phases. Any building, plant or infra structural project is considered as being a long term investment tying up capital for a longer period of time. Again depending on the type of project and client the financing approach will vary. A public body will normally operate within annual expenditure limits (budgets) whilst private companies or persons will try to obtain necessary financial facilities from either banks or from bond issuing mortgage banks. For a private client the prospect of return rates on the invested money will obviously be of great interest. The standard procedure is to take out mortgage finance based on the value of the project to be constructed.

Cost Allocation and Consumption

There is a strong dependence between the cost allocation/consumption and the different phases of the building process. This relation is illustrated in figure 8. The breakdown of the project in the phase model also gradually reduces the degrees of freedom of making technological changes to the project. On a project basis the average, relative distribution of the costs for a typical residential building is given in table 2 (Erhvervsfremmestyrelsen 1994).

THE PARTICIPANTS AND THEIR ROLES

Bygherre



	%
Materials	60
Plant/equipment	5
Wages (on site)	25
Designer fees	10
Total	100

Table 2 Cost Distribution for Residential Building

In the legal and economic context the *Bygherre* (client) initiates the construction of the project. Different types of clients are in practice represented by:

- a public body/authority
- a non-profit social housing co-operation
- a private person
- a limited company
- a dedicated "developer"

The role of the client can vary strongly depending on its competence and capacity. When more experienced, the client might perform several of the tasks normally being undertaken by other parties in the process. Some institutional investors (banks, insurance companies, pension funds etc.) have established their own internal organisations for initial development and conceptualisation of project ideas. At the other end of the skill range are the majority of private clients without any professional background, totally inexperienced, building for their own use for the first and only time.

Arkitekt og Ingeniør

The design team is formed by the different technical professions:

- architects
- structural engineers
- mechanical and electrical engineers
- surveyors
- specialist planners (i.e. landscape architect)

The design team normally holds a formal agreement with the client concerning the design and planning tasks. In the traditional context the architect is considered as being the client's prime representative, acting on behalf of the client in all external matters and engaged during all the phases of the process. He then handles a rather broad variety of functions, apart from the basic fixing of aesthetic and functional specifications also including technical, economical, planning and managerial matters.

When a client asks an architect to launch a project he determines the tasks and the internal distribution of functions in the design team and between the rest of the parties in the process according to a model elaborated by *Praktiserende Arkitekters Råd* (PAR). This model is founded in *ABR-89*. The model is rather independent and rigid in relation to the practice of construction, since the tasks it defines are to be executed despite the formal boundaries and organisational relations between the parties in the actual process.

It must, however, be emphasised that a certain - some would even say dramatic - development as a shift in the balance of power in the project organisation has occurred during the 1970s and 1980s. Generally this development has gradually reduced the functions of the architect - and thus his importance. In a vast majority of the larger projects the architect's most central contributions were in the overall aesthetic and functional conceptualisation process, often at a quite abstract level. Parallel to this change the consultant engineers, the material suppliers and in particular the contractor have taken over more responsibility in areas such as design, selection of materials, economics, quality control, management.

A key force behind this development undoubtedly originates in contractors' strategic willingness to undertake increased responsibility for overall time and cost management. So strong marketing efforts towards potential clients have emphasised the contractors' ability to execute projects at fixed prices and times. But also the technological development throughout the booming 1950s and 1960s should be considered as incorporating such long-term organisational changes. As the basic Danish

industrialisation concept, ultimately leading to the prefabricated house, allowed use of repetitive details from unit to unit and from project to project, this reduced radically the need for architectural detailing during the design phase. Consequently, perhaps deliberately and definitely with some success, architects refined the artistic approach of their profession within the industrialised building concept, thus leaving large parts of the decision making to other actors, primarily the contractors.

However in the 1990s the architects have regained some of the position previously held in the project organisation. With the emerge of the concept for *totalrådgivning* the architect has become a strong, driving force in the design and execution in a large share of the projects. Furthermore the architect has adapted several "new" functions like preparation of plans for care and maintenance and a participation in the daily operation of the building. To help clarify the roles of the actors in the building, the PAR has issued guidelines for the internal co-operation in the design team in connection with a project. The detailed distribution of work is shown in table 3.

During the initial phases prior to design the architect is gradually materialising the client's idea of a building. At this stage there is, of course, a strong liaison with the client, who retains the possibility for acceptance or rejection of the suggested project ideas. Based on the client's decision the project proceeds to the next phase - planning and studies. The architect's drawings now become an integrated and substantial part of the project information. The drawings contain information about the site location, the size of the site, conditions on the site, gross floor area ratio and local planning conditions.

Other consultants - representing independent companies - then enter the design team. Normally on a building project the structural engineer provides the structural design just as the mechanical and electrical engineer are in charge of electrical, heating, ventilation and sanitary installations. The surveyor ensures the positioning of the building in accordance with the planning permission obtained. Furthermore specialist planners normally come into action on projects of a more complex nature. For example town planners involved in area and infrastructure layout for larger groups of buildings; or specialist consultants in cases of polluted sites; or specialists, planners and managers serving together as advisors within technical and commercial fields relevant to the specific project.

The design team (chaired by the architect) now make preliminary estimations on the project budget, and time schedules indicating critical paths are outlined. The architect furthermore spends some effort working out a functional analysis of the project often going into great detail with each single room/part of the project.

Ultimately and prior to the design team's actual design work all information is collected, structured and presented in a briefing to the client, on the basis of which it decides whether or not to proceed with the chosen design.

During the following design phase the task for the design team first of all is to produce drawings for the project, but also a number of consultancy tasks are considered to be integrated in this design stage:

- project management
- programme drafting stage
- framework proposal
- preliminary project
- final design/main project
- implementation of the project

Guiding specifica-tions of services	1.Consultancy before design				2.Consultancy in connection with design					3. Consultancy in connection with execution		4. Consultancy in operation phase	
	ABR item 2.3.1. Client´s brief phase				ABR 89 item 2.3.1 Proposal		ABR 89 item 2.3.1 Detailing			ABR 89 item 2.3.1 Execution		ABR 89 item 2.3.1 Operation	
	1.1 presentation of ideas	1.2 planning and studies	1.3 initial client´s brief	1.4 client´s brief	2.2 programme drafting stage	2.3 frame-work proposal	2.4 preliminary project	2.5 final design/ main project	2.6 implemen-tation	3.1 construction management	3.2 site supervision	4.1 preparation of operation manuals	4.2 assistance with operation of the building
Client								( )		( )			
Architect	(( ))	(( ))	(( ))										
Structural engineer					(( ))							( )	
Mechanical & electrical engineer					(( ))							( )	(( ))
Landscape architect					(( ))		(( ))					( )	

Table 3 Architectural responsabilities

( ) Full assistance – (( )) Partial assistance

In connection with the project management task a project manager is appointed within the design team to undertake the contact with the client. A major job for the project manager is to supervise the progress and budget of the project. The project manager determines the detailed procedures for co-operation among the designers involved in the process at various times. He also chairs various regular meetings like project and client meetings. Finally the project manager is responsible for obtaining the building permission from the authorities, he is responsible for the tender process, and subsequent to the tender he calculates the complete budget on basis of submitted bids by the contractors.

In the programme draft stage an outline proposal is drawn up. The outline proposal consists of the architectural idea, function and environment. It also contains principles for the structure and service installations and the main selection of materials. It includes an organisational plan for the project as well as a plan for the upcoming tender process. The outline proposal finally contains calculations and specifications for the areas to be built-up. The drawings are now prepared showing building location and landscaping in scale 1:500 or 1:1000. Sketches of plans/elevations in scale 1:200 or 1:500 including perspectives of the building.

The architect prepares an estimate of the costs based on the previous cost frames in the client's brief. The architect also works out an estimate normally following the format covering the costs for:

- purchase of site
- development of site
- construction
- service installations
- furniture and equipment
- general administration
- contingencies
- value added tax

This estimate is based on the experience represented within the design team, and prices are traditionally based on units - either m² or functional units. Having this estimate at hand the client is now able to update its investment plans.

In cases where exceptions to existing rules are required it is normally the architect’s task to make the necessary inquiries to the responsible authorities. The client himself participates in meetings during the programme drafting stage in order to discuss upcoming proposals from the client’s briefing. The client formally accepts the outline proposal of the project before the design team continues working out the framework proposal. The framework proposal is a more extensive elaboration of the outline proposal described above. The choice of construction means and methods is described and motivated as well as more detailed plans for furnishings. The choice of tender form is now finalised, and so is an organisational plan for the project completion.

The design team continues detailing the drawings, and the time schedule for the design and the execution is updated. The architect now breaks down the budget in greater detail, stating costs for:

- site
- ground development
- site preparation
- sub-structure
- superstructure
- finishes
- surfaces
- mechanical services
- electrical services
- services
- furnishings
- site running and extreme weather conditions
- general administration, consultant fees, construction management, supervision, reproduction etc.

- contingencies
- value added taxes

The budget is supplemented with information on the index, on which construction costs are based and will be regulated, and also with the proposal for the tender form and conditions. Finally a general evaluation of the market situation and other circumstances that will influence the project and the execution is included. At this stage the budget must cover the total estimated expenses for the completion of the project. It thus serves as a cost target inside which the design team is committed to complete the project. The architect also notifies the relevant public authorities on the project.

As discussed above, the client is supposed to collaborate closely with the design team during this process. On the basis of the budget he updates the investment plan for the project and then finally approves the project in its present form as the basis for the commencement of the initial stages of actual design. In cases of a larger client organisation remarks from the future users are formally obtained and integrated here, too.

The first phase in the actual design of the building is the preliminary project. During this stage the design team develops the main dispositions for the building, and aspects like parking facilities, accessibility, surroundings, regional planning and fire regulations are discussed in dialogue with the public authorities. Drawings now have to fulfil requirements from the authorities in respect of the Building Regulations. The client delegates formal power to the architect to submit an application for a building permit. Besides meeting the demands of the Building Regulations the drawings must be supplemented by a summary of the discussions held between the design team and other authorities. The design team finally updates the time schedule and the budget based on the latest project information and revisions.

In the detailed design of the building, the project is elaborated, specified and detailed sufficiently to function as the prerequisite for the final building permission, the tender, the contract negotiations and the signing, and the subsequent execution. The detailed design is composed of a description including the conditions for contract and contract specifications, bill of quantities, a time schedule and a set of detailed drawings. The architect is in charge during the tender process leading the negotiations with the contractors as well as evaluating the incoming bids. The tender documents will of course state a programme, giving the starting and completion dates and intermediate deadlines carrying sanctions for the various individual contracts.

In terms of costs, the architect updates the budget in accordance with the price fluctuations, partly using the changes in the agreed cost index partly considering special conditions in relation to the labour market and business market situation. If alterations to the project are agreed this also calls for updating of the budget. The budget is adapted to the chosen tender form and divided into the relevant sections and sub-budgets. Following tender the architect submits a report to the client with an evaluation of the tender result, including comparison to the budget estimated prior to the tender.

In cases where the result of the tender exceeds the budget the client might insist on a revision of the project in liaison with the architect. Such a revision is free to the client. However, should the exceeding tender result be due to possible agreed fluctuations such as agreed price regulation; agreed variations; or unknown conditions at time of tender, then the design team is entitled to a fee for the additional work required when revising the project.

The client’s main role during this stage is to participate in eventual project revisions due to budget excess (and/or time schedule overruns). In connection with the subsequent negotiations with the bidding parties he evidently can be forced to update his investment plan, but finally the contracts with the contractors will be signed. The client is probably also involved in working out the schedules for the contract management and supervision in accordance with the public rules and in accordance with the regulations concerning quality assurance.

During execution the design team is involved in a follow-up on the intentions laid down in the drawings and specifications. The follow-up also includes assistance to the construction manager and to the supervisors of the works, and the design team incorporate necessary

changes and alterations in the drawings. The architect may be present at site meetings chaired by the construction manager.

Bygherrerådgiver/byggestyring (construction manager)

The construction manager[3] - normally a member of the design team - is appointed prior to start up of construction, and he works on behalf of the client in detailed matters of construction. The construction manager operates according to an agreement with the client stating the distribution of tasks and responsibilities. The construction manager's direct organisational counterpart is the contracts manager representing the contractors and this relationship is regulated according to the rules specified in the general conditions. The distribution of competence is defined in a plan of the site organisation.

The construction manager elaborates reports at agreed intervals, stating the progress of the project. Aspects treated in these reports are works progress, works quality, budgetary situation of the project, and thus the construction manager makes the client approve of any action taken during the construction. The construction manager should also keep detailed records of the weather conditions during construction and likewise register lost time as he is in charge of the time schedules and the necessary revisions of these.

Works inspectors are engaged to control the contractor's progress in accordance with the latest revision of drawings and specifications, and they report any variation to the architect. This inspection of works during construction is of course a crucial item with the aim of ensuring that works are carried out and progress as determined in the contracts. In practice inspection is executed as spot checks of the works during construction. The level and intensity of checking is fixed according to quality control plans laid down prior to execution. When deviations from the agreed level of quality are observed a list of deficiencies is worked out prior to the final handling over. The contractor then takes corrective action, and the construction manager approves the work when the agreed quality is reached.

Quantities are controlled in accordance with guidelines specified by the construction manager, and the progress payments to the contractors are released on the basis of these quantities. Financially the construction manager is therefore in charge of the accounts related to the construction, and he certifies the progress payments to the contractors. The construction manager is also responsible for co-operation with the authorities from start to finish. At the end he informs the relevant authorities about completion of the works, and obtains the permission to use the building. Lastly the construction manager is in charge of the final inspection closing the contractors' liability and warranty period and with that also responsible for the release of the performance guarantees.

When eventually the building is handed over to the client the architect may become involved in the operational phase of the building. The involvement is normally consists in consulting services regarding operation and maintenance of the building. The architect will then define operation and maintenance plans based on information and instructions from contractors and suppliers and assist in executing these.

***Entreprenør* (the contractor)**

An *entreprenør* (contractor) is the party holding a contract with the client on the execution of a part of or the entire work. The *hovedentreprenør* (main contractor) can subcontract whole or parts of his works to an *underentreprenør* (subcontractor) establishing a client - contractor relationship between the two parties. An *entreprenør* can be any type of company ranging from large multinational general contractors to small craftsman-type companies doing specialised tasks.

[3] The usual translation of the Danish *Bygherrerådgiver/byggestyring* is "construction manager". However, this is not the same as the anglo/american construction manager. The latter has evolved out of general contracting, and manages trade contractors on site. The *Bygherrerådgiver/byggestyring* has evolved out of trades contracting and takes over architect's responsibilities for managing the site works.

Other Actors

The supplier Normally a building materials production company or a supplier that provides contractors with specialist materials or components. It may be specifically nominated by the design team or the client. In recent years suppliers have been increasingly involved directly in the building process, even in early phases. The intention of this is to utilise the experience held by the material producers and to adapt the project design to the specific properties of the material. This approach has become important due to the fact that complex components are more and more frequently used in buildings.

Another development trend is the emergence of the supply and fix producers of materials with the migration of the producer towards a status as specialist contractor either directly or through linked, authorised contractors.

The User Persons who are going to use, work or live in the building during its period of function. On larger projects the user influence is formally recognised in the design phase, i.e. represented by specially appointed groups.

The Public Authority Local or government authority co-ordinating and approving technical and planning matters

The legal adviser Specialist adviser occupied with detailed legal matters. Normally considered to be the client's ordinary legal adviser.

THE PRACTICE OF CONSTRUCTION

Organisational arrangement for construction projects vary from project to project. The decision on the organisational set-up is typically based on the project characteristics such as like type of client, complexity of the project, aesthetic requirements, function ability, level of prefabrication. Also long term historical changes between the market segments have influenced the attitude to organisational alternatives. For instance the above mentioned shift from new industrialised, large-scale building projects towards smaller, more individual building types (and renovations) meant a significant change in the demand for qualifications and roles to be attended to by the participants in the construction process. Such developments have created more trend based criteria of the selection of organisation form.

It is important to understand the client's different legal and practical position in relation to the selected contract model. To summarise there are three typical ways for the arrangement of the organisation of the building process:

- *fagenentreprise* (traditional contracting - individual trades)
- *hovedentreprise* (general contracting)
- *totalentreprise* (design and build contracting)

Fagenentreprise

On the other hand this set-up is considered to require the most detailed project design and planning, since each individual contractor is only responsible for his own work. This makes the interface between the trades very critical. Historically the individual trades contract (the traditional contract) was dominating as organisational structuring of projects up till approximately 1960.

Figures 9 and 10 show the structure and process of the traditional form of separate trades contracting. The number of *entreprenør* of course varies from project to project depending on the size and the complexity of the project. The contractors are all separate trades like carpenters, bricklayers, floor layers, and electricians. As equal legal parties all trade contractors have also equal status in respect to communication with the client. Within his contract each contractor is entitled to appoint subcontractors to carry out a part or the whole of its contract.

The client or his representative is responsible for the co-ordination of each individual trade in respect to time and progress. The direct contract between the client and the contractors allows the client a direct and substantial influence on the output, since it is directly involved in vital decisions on materials and construction details. On the other hand this set-up is considered to require the most detailed project design and planning, since each individual trades contractor is only responsible for its own work. This makes the interface between the trades very critical. Historically the individual trades contract (the traditional contract) was dominant as organisational structuring of projects up till approximately 1960.

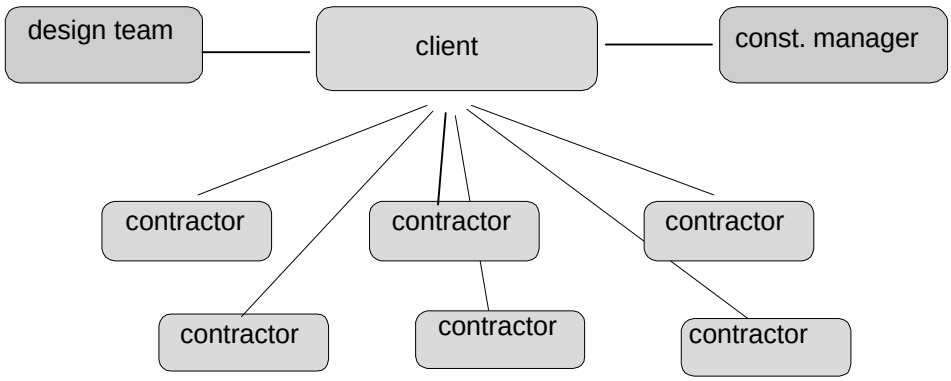


Figure 9 Contractual relations between the parties Fagenentreprise

Hovedentreprise

From around 1960 the general contracting arrangement gained increased importance, and this form is illustrated in figures 11 and 12. This development was caused mainly by the need for a clearer path in respect to legal responsibility and communication between the contractor and the client.

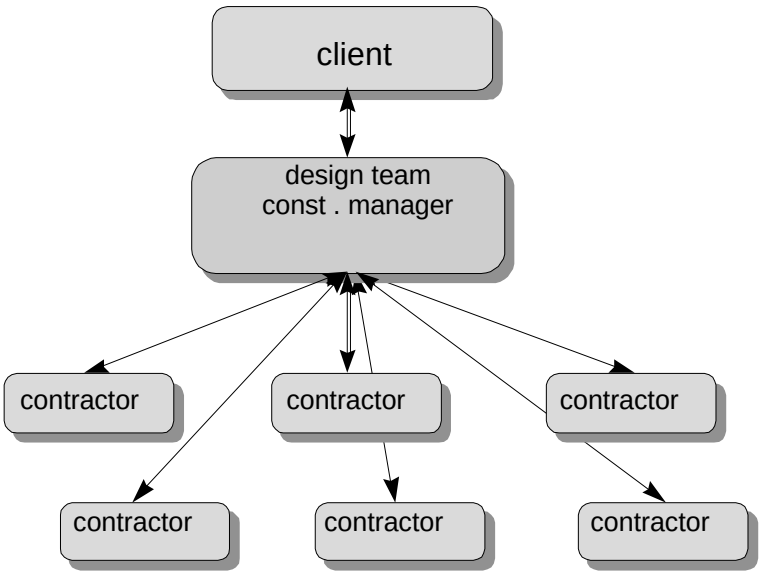


Figure 10 - Process, finctional ans communicational relations between the parties - Fagenentreprise

Furthermore the technological consequences of the industrialisation reduced the relative significance of some specialists trades in relation to the expansion of the general contractors

field of activity. The best-known example is given by the emergence of the precast concrete panel greatly minimising the role traditionally played by the bricklayer.

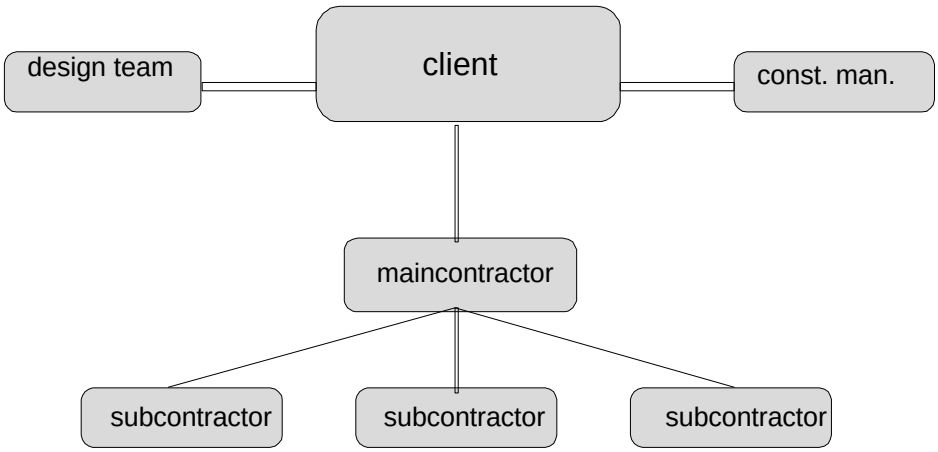


Figure 11 - Contractual relations between the parties Hovedentreprise…

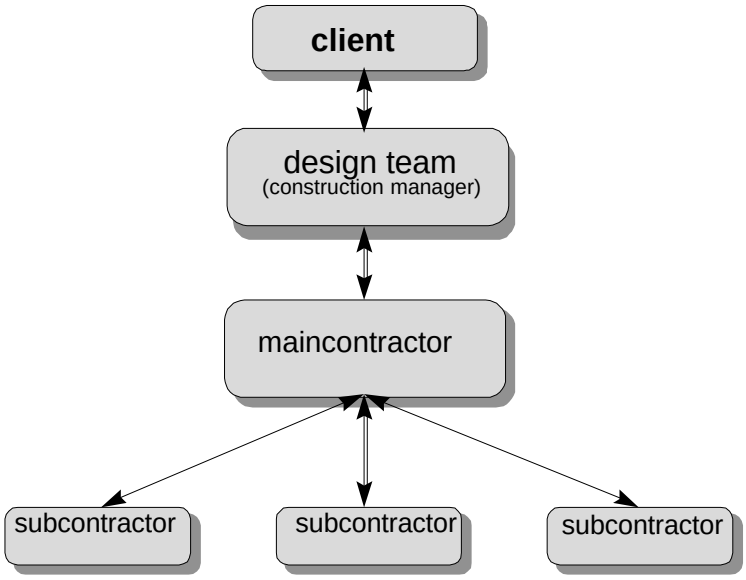


Figure 12 - Process, functional and communicational relations between the parties - Hovedentreprise

A substantial difference in comparison to the individual trades contract here only one contractor, the *hovedentreprenør,* relates directly to the client (and his representative). All other contractors have a status as *underentreprenør* to the hovedentreprenør, with whom all legal, technical and managerial topics formally must be handled. Likewise the main contractor, carries all responsibility in relation to the client for the work of the subcontractors. The design is carried out by the design team nominated by the client. For legal reasons the tender documents are fairly detailed, since they are the basis on which the actual construction takes place.

Totalentreprise

The design and build contract is the industrialised building approach in its purest form, and is illustrated in figures 13 and 14. With this set-up the client leaves maximum responsibility and decision making to the *totalentreprenør* (design and build contractor). The principle aims at

minimising the costs spend on the design phases of the project by letting the contractor's constructability view influence the design and planning concepts. As shown the design team is nominated directly by the *totalentreprenør* .

Basically the client only specifies the overall functionality, the level of quality and a deadline for the finished product. On the other hand the client must also be capable of analysing the tender-proposals from the design and build contractor in order to decide whether he actually achieves the desired result within these.

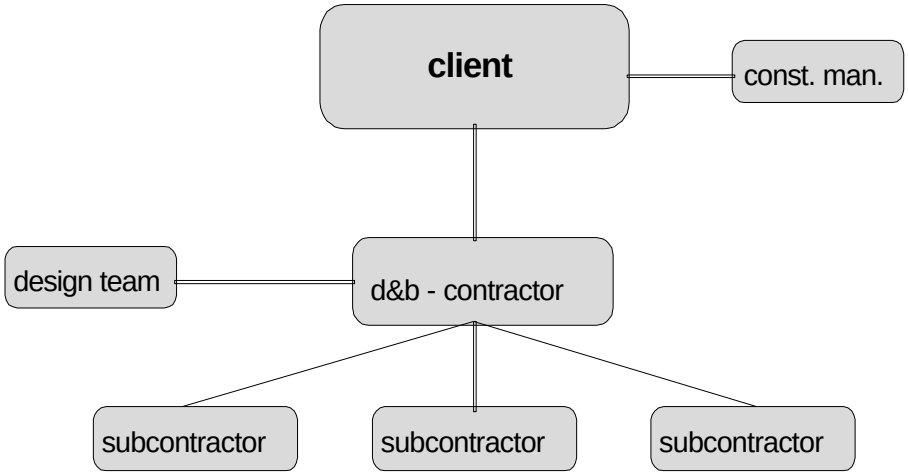


Figure 13 - Contractual relations between the parties - totalentreprise

Since it has little or no influence during the actual construction process the formulation of the contract becomes crucial in respect to its legal as well as practical consequences. As described earlier the design team has regained some of the previously held position in the building process. This has led to a hybrid practice of design and build contracts where the client makes the initial direct contact to the architect and engineer for a preliminary conceptual dialogue. Following that the client can make a contract with a design and build contractor in the normal fashion. The intention of integrating the parties in the design team is to give the client a direct influence on the project as opposed to the design and build contract.

ISSUES IN PROJECT MANAGEMENT

Planning and management The purpose of the planning and management is to make it possible to carry through the intended project in the context of finance, technique and time. To the client planning and management of the execution is only a minor part of the activities during the whole project. For the contractor, however, this is obviously of particular interest, since the major part of his work is conducted in this phase.

The client The client and his design team will first of all focus on the overall time schedule and the deviations in relation to the intended taking over of the building. Depending on the organisational model also the co-ordination and interfacing between the contractors might be of particular managerial interest to the client's representatives.

On the financial side the client must elaborate a sequence of progress payments in order to have appropriate funding available at given moments during the project. In principle the client must take all planning to the desired level of detailing prior to the tender, because planning information form a central part of the documents on which the tender is based.

Time A principal programme is elaborated showing the variety of tasks and the contractors assigned to them. The schedule must indicate start and completion dates for each individual task highlighting the interdependent sequences of construction process. Critical paths are identified and milestones in the project are defined.

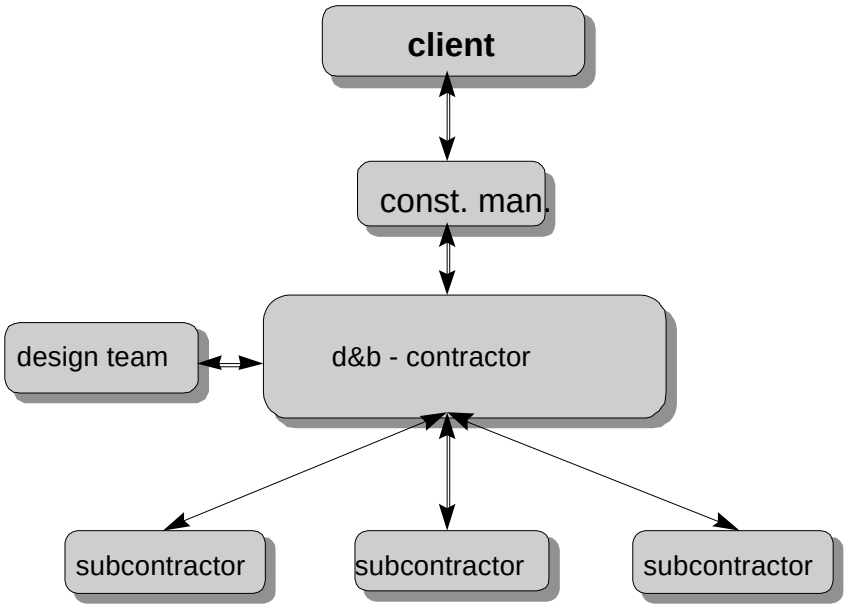


Figure 14 - Process, functional and communicational relations between the parties - total entreprise

In building projects a quite large number of different trades and typically 20 -50 contractors are involved, making it very critical to co-ordinate all activities. The industrialised building process with extremely condensed time schedules is obviously very sensitive to delays and disruptions causing subsequent overruns of time, often at the aggregated project level.

The growth of refurbishment activities certainly has added an extra dimension to the difficulty of planning and management, since buildings are often occupied during the renovation process. Planning then calls for a close co-operation between the client's consultants and the contractors and perhaps also user groups.

Finances The financial planning must clarify the amount of money that has to be provided for the project to be realised. A plan of finance is established outlining all the major items. In the case of extended building periods, increases in prices must be taken into account and incorporated in the plan of finance.

Administrative planning This type of planning contains:

- definition of relations between the client, the design team, the relevant authorities and the contractors
- organisation of the work implied in the detailed design, making sure all necessary drawings are available at the right time
- decisions on the construction management and the level of reporting to be done by the construction manager and the contractors
- materials procurement in case the client has decided to act as supplier
- employment of new personnel and equipment for the new building

During the construction period the client performs inspection procedures on site and takes corrective action, if anything starts to go wrong. The detailed registration on the site is made by the works inspectors as a part of the supervision of the work, noting start and completion dates for all operations and the reasons for any kind of deviation. The registrations will normally be published in reports from weekly site meetings. For the contractors not yet on site these progress reports are vital, since they will reveal alterations in starting dates for their works.

Quality management is seen as a central tool for the successful course of the building process. The prime target of quality management is clearly to ensure - and prove - that the building is produced to the specified level of quality and to the standards widely accepted in the market as good workmanship. Since quality management has been formalised not only in its controlling procedures but also as being based on rather large amounts of written

documentation, other types of more practical quality management methods have now been implemented at the company level.

However quality management is not only seen as a formalisation of the building process. Great emphasis has been put to the motivation of all the actors involved in the process including a focus on the necessity of having the proper qualifications for doing the job.

The Contractor With the critical condensed time schedules of the industrialised building process good planning has become a crucial factor to contractors' financial results. The planning of construction sequences is important, because lost time cannot easily be regained by increasing the amount of manpower. Merely increasing the number of operators on the site is practically impossible due to the linked sequences of construction, limited space and the limited capacity of plant and tools. Thus contractors spend more effort in planning the logistics of the production process to ensure that the right amount of material, machinery and manpower is at the right place at the proper time.

This requires minute preparation. An elaborate plan typically contains the following main items:

- all necessary information for the planning to be done
- main guidelines in the organisation and management
- time schedules
- selection of methods of construction and the necessary plant
- layout of the site
- temporary works
- financial planning
- preparation for the works instructions
- system for reporting
- detailed planning for the commencement of the works

Normally the contractors work to two levels of detail during the planning. The first step is to prepare a pre-tender plan, which has a sufficient level of detailing for him to prepare his bid for tendering. However planning must always be taken to a level from which the job can be executed using the defined equipment and within the duration of the promised time schedule.

Having obtained the contract the plan is always detailed to a further level applicable to practical construction. This detailed planning is based on the information obtained through:

- the contract documents including drawings, specifications, conditions etc.
- a visit on the site
- the bid
- additional information after the tender has closed

The contract documents will be more or less the same as the tender documents, but modified in accordance to the alterations agreed during the contract negotiations. Alterations often concern changes of the time schedule for specific parts of the job and of the layout of the site. If the contractor has introduced alternatives to the original project design these are also discussed at this stage and often accepted by the client. A site visit may be important, because information relevant to the construction and not available in the tender documents must be obtained. The contractor then defines the site layout and picks up knowledge about the temporary works needed to do the job.

The bid is often calculated by specialist estimators at the contractors' main offices. The information elaborated during the tender must have a format enabling the contracts manager's team to do further detailing for the eventual, actual construction. When the tender has closed and the contractor is in the process of getting the job in negotiations with the client and his representatives, it is common practice gather as much additional information as possible. Often methods chosen by competing contractors are taken into consideration for the job execution. Suppliers or producers of materials may offer uninvited materials bringing new alternatives into the project. Contacts with local subcontractors and suppliers of materials and surveys on the availability of local labour are of course also central.

CONCLUDING REMARKS

In this rather descriptive textual form it has been attempted to pin down the sphere of operation of the Danish contracting system. The description takes its starting point in the formal representation of the system, i.e. in the extensive and detailed official (written) documentation. Subsequently, as the prsentation of it through large passages is close to mere description, it might have seemed appropriate to make a more abstract analysis. On the other hand a critical investigation of contracting system efficiency would have been quite another analytical task, especially complicated in relation to the comparative aims of le Groupe Bagnolet.

The relationship between formally laid down procedures and their appearance in practice is of course an important subject of discussion. The scale and substance of the divergence between these two “realities” undoubtedly vary according to not least nationally and culturally determined conditions. It is, however, the firm conviction of the authors of this paper, that the structuring and regulating influence of the Danish contracting system on actors and activities in construction must be characterised as direct and strong.

In a European context this feature is partly embedded in the political framework of the Scandinavian sphere, where scopes for actions are fixed through political and social negotiations. But also specific historical conditions in the post-war development of the Danish construction technology underline the impact of the contracting system, principally illustrated by the emergence of the industrialised production systems, which were implemented within the system’s apparatus of rules, procedures, functions and activities throughout the post-war decades. As shown this systematised alliance between industrial and institutional actors was highly effective in achieving defined goals and has proven of considerable momentum. However, the model seems rather unfit for handling rapid changes in market and technology demands related to internationalisation trends - a problem which is probably the biggest contemporary challenge for Danish construction.