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Specialist contractors: A review of issues raised by their new role in building

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The paper describes a study of the newly emerging role of specialist contractors in the UK building industry. It identifies a common strategy employed by specialists in dealing with the complexity and diversity of modern building. This is to maintain a consistent operating core insulated from the firm's environment. It also highlights particular problems which arise in current practice in respect of contracts, design responsibilities, coordination of work on site and the incidence of variations. It also shows that opportunities and problems arise from the power of modern information and the demands for quality assurance. All these individual issues give rise to a need to review the training of operatives and specialists' investment in research and development. For the rest of the industry, the study suggests a need to develop better ways of evaluating competitive design proposals from specialists.

Keywords: Specialist contractors, design, contracts, site coordination, training, research and development, design competition

Introduction

The emergence of specialists into a key role within the building industry has many important implications for clients, consultants and contractors. The nature of the changes caused by this move from general to specialist contracting are becoming clear. Thus there is a need for a general review of the new situations now emerging in order to guide future research and to help clients and practitioners understand the issues raised by the structure of today's building industry.

The Building Centre Trust provided financial assistance for the Centre for Strategic Studies in Construction at the University of Reading to undertake such a review. This was carried out by the authors between June 1987 and April 1988.

A steering committee was established comprising:

Mr John George	(Building Centre Trust)
Mr Geoffrey Ashworth	(Monk Dunstone Associates)
Mr John Partridge	(Howell, Killick, Partridge and Amis)
Mr Hugh Try	(WS Try (Holdings) Ltd)

The review began by considering the project information needs of specialist contractors

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since it was felt that this topic would provide a sharp focus onto the changes underway. It was carried out using a detailed questionnaire filled in at interviews with the senior executives of 13 specialist firms. Although the investigation centred on matters directly related to project communication, the questionnaire was constructed so as to enable other areas to be studied which the researchers and the steering group considered to be important.

The firms selected are mainly concerned with industrial rather than traditional craft products. In this way the study was more concerned with the emerging nature of building work than with traditional methods and organizations. It did not therefore seek to provide a representative review of current practice but dealt with some of the more interesting and important features shaping today's building industry.

Further information on the size and structure of the firms interviewed is given in the Appendix. In the majority of cases the managing director was interviewed, although other senior executives usually provided the majority of the input from their own areas of responsibility.

The main problems arising from interactions between specialists and others in the industry, raised in the interviews, were the subject of further interviews with two firms of architects, two of construction managers and two of general contractors.

This paper describes the overall conclusions drawn from the study but also draws on other related research. Thus it provides a review of the current situation facing specialist contractors and some of the implications for the rest of the industry. It also seeks to provide a way forward by describing the further research identified as necessary during the study.

Today's building industry

Building today uses a very wide range of technologies and the number is increasing. One measure of this is that in 1922 the first Standard Method of Measurement was arranged in just 16 trades. The Common Arrangement of Work Sections used to structure the 1988, SMM7 comprises over 300 sections each of which represents the work of a different specialism in today's building industry.

Such is the complexity of today's buildings that no one firm has a detailed understanding of all the technologies involved. Inevitably a large part of the building industry is made up of firms each of which specializes in a specific, relatively narrow technology. Figure 1 illustrates the remarkable growth in the number of specialist firms in recent years. This growth is continuing as the number of specialists involved in all kinds of building relentlessly increases. It is happening because individual buildings have to meet ever more complex and subtle requirements; this process has been underway for many years and shows no signs of being reversed. Indeed, if anything, building users' demands and new specialisms to provide for them are being added at an increasing rate.

The development of a building industry based on large numbers of specialists has progressed far enough for the main implications to be painfully obvious. Designers need to become technology brokers, general contractors need to become construction managers and the specialists themselves have to take on many new and unfamiliar responsibilities. In other words many people within the industry face major changes in their responsibilities and in the key relationships which shape their day-to-day work. Generally they have received no training for their new roles. The methods and procedures they use tend to be modified versions of standards developed very largely on the twin assumptions that architects design

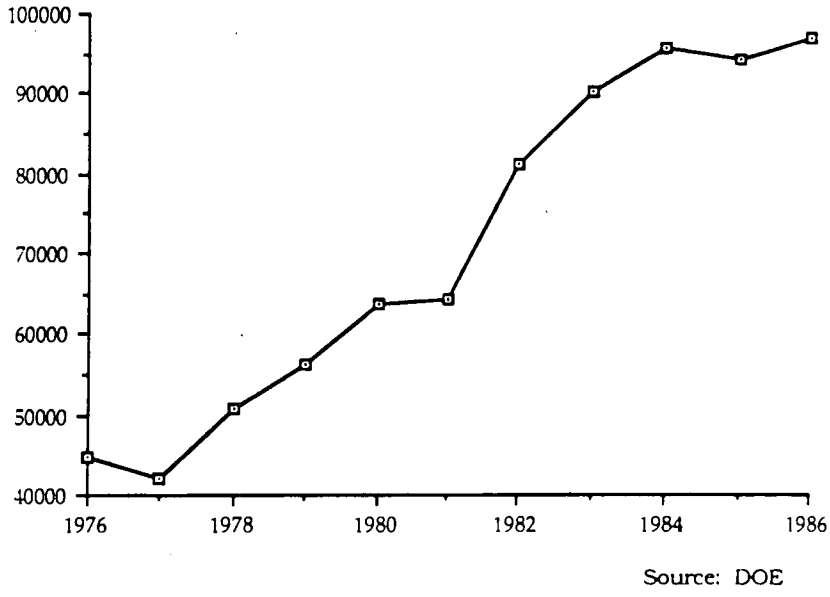

Fig. 1a. Growth in number of specialists

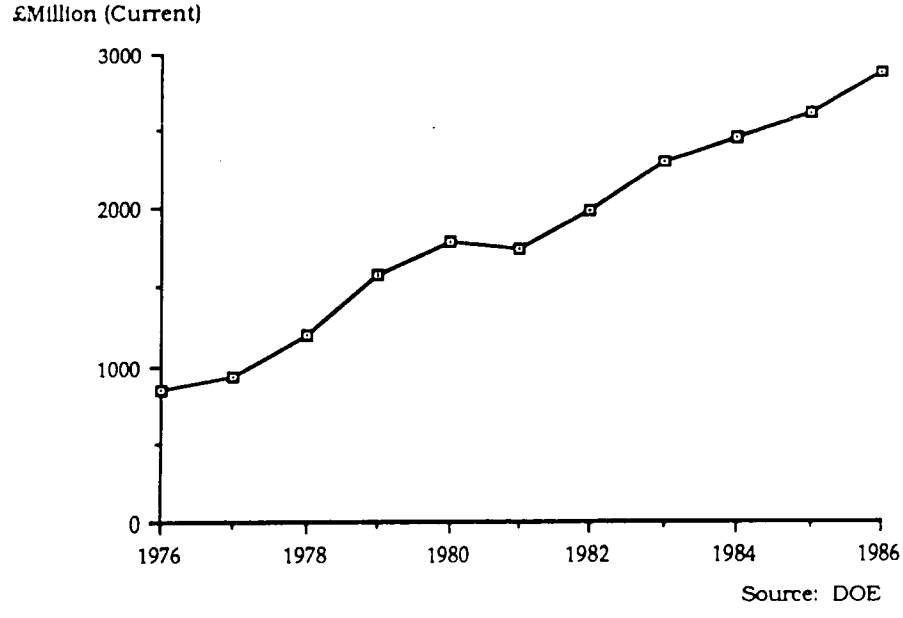

Fig. 1b. Growth in specialists' output

buildings and general contractors construct them. Inevitably practice today is very varied and the multitude of different approaches to procurement and forms of project organization in common use presents a confusing picture to clients, consultants and contractors alike.

Specialist contractors provide the basic units of today's building project organizations whatever procurement approach is adopted. It is therefore useful to start by defining their role.

The specialist contractors

The term specialist contractor is used to describe a firm which constructs specific elements of buildings. Traditionally such firms acted as trade sub-contractors to a general contractor. Historically design details were settled on site in discussions between the sub-contractors and the architect. In recent times there has been little or no contact of this kind. For the traditional trades this remains the case and general contractors provide the construction interface with designers. For example, this is normally the case in respect of brickwork, in-situ concrete, formwork, carpentry, plastering, glazing, painting and other traditional craft work. In practice the responsibilities of specialists (especially industrial rather than craft-based specialists) are often wider and frequently include at least some design decisions. These may be merely at the level of craftsmanship. This is selecting the material to be used in a specific position from amongst a batch delivered to site in accordance with design decisions made by others and usually also includes selecting appropriate established construction details. However mundane these decisions, the choices made by the craftsman directly influence the performance of the finished building. This takes the operative and therefore the firm which employs him into the realm of design decisions.

Specialist contractors increasingly bear more than simple craftsmanship design responsibilities. Figure 2 illustrates the range of possible responsibilities from fitness for purpose to craftsmanship. Although the figure shows a simple, general sequence, in practice decisions are complexly inter-related so that in many projects the sequence illustrated may be reversed. Also the range of responsibilities in Fig. 2 clearly encompasses decisions about design, manufacture and construction. These provide yet a further dimension to the possible responsibilities carried by specialists. However, bearing these factors in mind, the stages illustrated in Fig. 2 provide a good basis for describing the variety of contemporary practice.

A specialist responsible for fitness for purpose must establish the needs which his work must satisfy in terms of the client's interests. Whereas responsibility for element design implies that others have determined the client's interests and expressed them in performance terms. Thus, taking a lift specialist as an example, in the first case a client's interests may be that no-one using his new building should wait for more than 15 seconds for a lift and that all normal deliveries can be conveyed by lift. The specialist will need to study the proposed pattern of use of the building and turn this into a detailed statement of the loads to be carried. In the second case, responsibility for element design, the specialist can rely on someone else providing him with the detailed performance specification. His responsibility is then limited to producing a design which satisfies these specific requirements.

Responsibility for detail design implies that others have determined the overall form and style of the element. In this case the specialist's responsibility is to select materials, components and construction and fixing details which work properly within the given element design. Shop drawings take design one stage further to provide the information

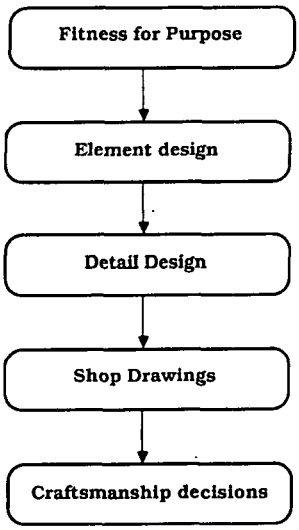

Fig. 2. Range of specialists' design responsibilities. Note that specialists may enter the process at any of the stages shown

required to manufacture all the required components. Fairly obviously, when the selected answer used standard components there is no need for a project-specific shop drawings stage. Whether standard or individually designed components are used, specialists may produce shop drawings for others to manufacture or may undertake manufacturing themselves. In both cases shop drawings involve specialists in many detail design decisions.

The final stage of design responsibility is exemplified by the day-to-day site-based decisions which all operatives must make. These are much more significant with established craft-work which uses general materials than with work which comprises site assembly of factory made components. However, even in the second case operatives select one component rather than another, deal with tolerances in the position and alignment of components and adjustments within fixings. All these decisions affect the precise form of the end product. They are commonly referred to as workmanship. An important development is that the change from craftsmanship to the assembly of components reduces operatives' discretion and their apparent control over their own work. This inevitably makes basic site work less satisfying and more difficult to manage. It is also at this level that the orderly progression of specialists' responsibilities illustrated in Fig. 2 is often interrupted by the use of labour-only contractors. While this makes no contractual difference to specialists' responsibilities, in practice labour-only sub-contracting reduces their concern for operatives' training, welfare, safety, employment prospects and general well-being. As we shall see this in turn affects the end product.

The exact combination of design, manufacturing and construction responsibilities chosen for particular building elements depends on technical and commercial considerations specific to individual projects. The overall effect is that many firms have a vague or mistaken understanding of the roles of others with whom they must work. This inevitably leads to confusion and inefficiency. There is therefore a strong case for research aimed at identifying the different roles which specialist contractors may be required to undertake. There is some justification for anticipating that there are very few essentially different such roles. One basis

for this optimism is the similarity between the traditional collaboration on site by architects and craftsmen in settling design details and the modern collaboration between architects and specialist designers. This later process takes place at the drawing board and in the research laboratories and test rigs of industrially based specialists designing, manufacturing and installing sophisticated components. So although the technology has changed and the relationships have become much more formalized, the essential nature of joint design is common. At present the industry is in transition and the apparent complexity of contemporary practice obscures the common ground. Research which clarified the fundamental roles and identified essential differences should help to make the building industry a more orderly and hopefully a more efficient place.

As things stand specialists must do what they can to impose order on the diverse demands made upon them. One of the key ways in which they do this is reflected in one characteristic shared by all the specialists interviewed irrespective of their precise responsibilities. This is that they run what can be described as a 'tight ship'.

The tight ship

Successful specialists run a very tight ship. They know their specialism thoroughly, have it well organized internally, and have no wish to diversify into other fields. If anything the tendency is to increase specialization; several of the firms interviewed used to have other interests which they have either abandoned or hived off into a completely separate organization.

Not only is the specialist well-organized internally, but his relationships with his suppliers give rise to few problems in terms of satisfactory performance by the supplier or by the goods he supplies. The fact of specialism means that suppliers are usually few in number and have an intimate and continuing relationship with the firm.

This rather happy situation of choosing a role in life and sticking to it obviously depends upon an adequate supply of work in the chosen specialism. In the current state of the construction industry this is not too difficult to arrange, although the philosophy is also at the mercy of changes in fashion or advances in technology. Because of this one or two of the firms interviewed, particularly those in rather ephemeral areas, are looking at new areas of work, but they are rigorously keeping such operations separate from their main activity (e.g. by employing different staff).

It is significant that the specialists' main problems are in their relationships with the rest of the building industry, in particular during site work.

It is therefore accurate and helpful to view specialist firms as being made up of a well-organized core of work plus boundary control activities which insulate the core from the uncertainty and variety of individual projects. In today's building industry the boundary control systems must cope with the varied requirements of a bewildering variety of different project organizations.

Specialists with an essentially engineering background and those drawn into building from other industries tend to have well-developed boundary control processes. They are able to operate reasonably comfortably in today's building industry. In contrast, the traditional craft specialists have poorly developed boundary control processes. This is largely because they are used to relying on general contractors to provide everything needed to integrate their work into individual projects. As a consequence, the management-based procurement

approaches often face them with novel and unexpected demands for which they are ill-prepared. It seems necessary for traditional craft specialists to develop some means of organizing and standardizing the flow of information from different projects. This may well require some form of franchise arrangement which provides modern management systems and training to small independent firms. Such developments will necessarily be market-led but there is a clear need for the traditional specialists to provide for themselves reliable access to the latest technical and management knowledge.

The identification of the tight-ship phenomenon leads to a useful way of viewing project organizations, which is illustrated in Fig. 3. This recognizes that in today's building market place, efficient firms are organized into a consistent operating core based on their individual specialism. Surrounding this and insulating the core from the variability and uncertainty of the market place are flexible boundary control processes. This applies to designers and managers just as much as to specialist contractors. Indeed good designers have developed a network of competent specialist designers, whom they trust and enjoy working with. Similarly good contruction managers bring to any project a network of tried and tested contacts. Thus project organizations are formed by linking the boundary control processes of all the firms whose specialism is required.

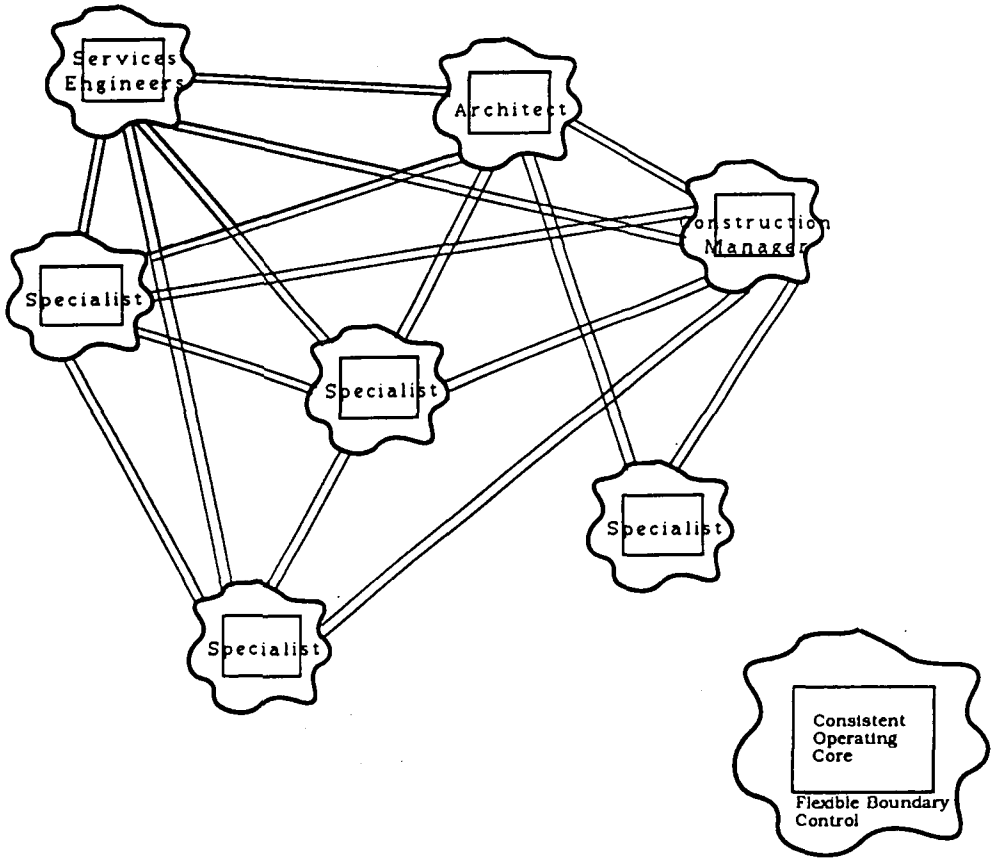

Fig. 3. Modern project organization

Research aimed at identifying and evaluating the effectiveness of the kinds of boundary control processes which exist in practice is likely to enhance our understanding of contemporary building practice. This understanding could well provide a basis for better project management. Managers necessarily deal both with roles and relationships. Core roles are reasonably well understood, but the way in which relationships structure the performance of organizations is generally less well understood. In this way, recognizing and studying boundary control processes could provide a useful way of researching contemporary building project management.

Project organizations

Specialist firms in the building industry do business within many different patterns of project organization. Figure 4 illustrates three basic patterns. The diagrams illustrate only the formal contractual relationships and therefore ignore for the moment the pattern of design and management coordination required to make the various project organizations effective. Figure 4a shows the specialist as sub-contractor directly employing the operatives; Fig. 4b shows the same arrangement but with the operatives employed by labour-only sub-sub-contractors; Fig. 4c shows an arrangement which is fairly common for mechanical and electrical services. It is also used on occasions for other building elements. The services firm acts as a sub-general contractor organizing the services specialists, some of whom will use labour-only sub-sub-contractors.

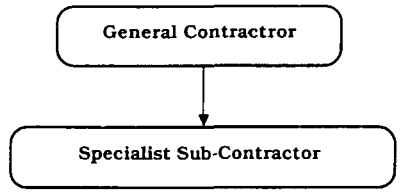

Fig. 4a. Specialist directly employs operatives

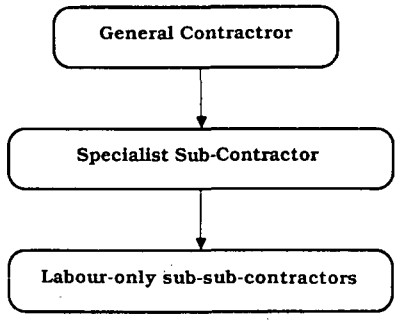

Fig. 4b. Specialist uses labour-only contractor to provide operatives

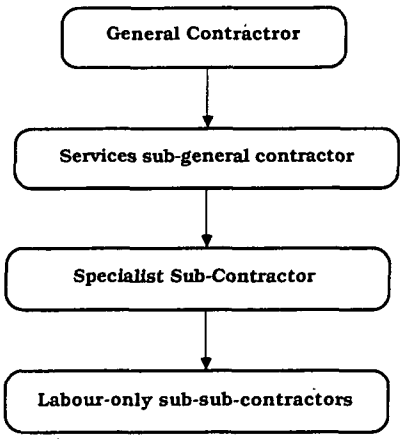

Fig. 4c. Specialists employed by sub-general contractor

As described earlier any of the specialists shown in Fig. 4 may be responsible for the design, manufacture and construction of their element. Alternatively they may be employed to construct a design produced by others which may also use components manufactured by others. In any of these cases they may be a domestic sub-contractor or a nominated sub-contractor. In the latter case they will normally enter into a design warranty agreement with the client which adds a further complication to their formal relationships.

Figure 4 shows specialists employed directly or indirectly by a general contractor. Nowadays the place of the general contractor is often taken by a management contractor. Alternatively specialists may contract directly with the client in a construction management approach.

The most usual basis of engagement is still sub-contracting to a general or management contractor, but rarely now as a nominated sub-contractor. There are, however, notable exceptions – some firms for the majority of their work contract direct with the client, sometimes (though not always) under a construction management arrangement.

The general preference amongst the firms interviewed is for contracting with the client, mostly because of better arrangements for payment. On the other hand, a few of the firms (one of them a large engineering services firm) preferred working directly for a contractor.

There was a fairly widespread dislike of management contracting, because as one specialist contractor observed, it appears to give management contractors authority without responsibility and specialists responsibility without authority. This highlights a problem which is based on a fairly common misunderstanding discussed in more detail in the section on site coordination. In spite of their apparently disadvantaged position some well-organized specialists saw advantages in the managment contracting approach. Ability to cope with its demands for formal paperwork and fast-track performance gave them advantages over the other less competent firms who would not be asked to tender for the large, complex projects on which management contracting is usually used.

Thus specialist contractors may face many different project situations, each of which has different commercial implications. The complexity of today's building market is illustrated by recognizing that the practical combinations of the arrangements described above provide over 30 very different contractual situations in which specialists may find themselves. The

demands of each vary, often considerably. For example, a number of problems surround the greater demands on specialists' management made by management contracting and contruction management approaches. Specialists are often required to provide plant, equipment, welfare and safety which has traditionally been the responsibility of a general contractor. More onerously, specialists are increasingly given responsibility for coordinating their work with that of other specialists.

The new requirements vary from project to project, often are not clearly understood by everyone involved and, as a consequence, place unpredictable demands on specialists' management. This situation gives rise to two requirements. The first is for management training. This is necessary for specialists but also, as we shall see, is needed by management contractors and construction managers. The second urgent need is for greater clarity and consistency in the definition of roles and responsibilities in management-based procurement approaches. These form part of formal contracts which raise yet further issues for specialist contracts.

Contracts

Current contractual practice varies in different parts of the country. Novel forms of contract are widely used for major projects in London, especially in the City and Docklands. Traditional arrangements based on the standard JCT lump-sum form (with quantities) are still the norm elsewhere although minor amendments are often made by clients. However, the use of one-off forms produced by clients' own lawyers are being used to an increasing extent fairly generally throughout the South-East and beyond.

A few of the firms interviewed are able to use their own form of contract, especially with private clients. Some of the smaller firms often work for private clients (outside London) without any formal contract.

It was said by a few of those interviewed that firms who worked regularly in and around London were used to the rather cut-throat methods which applied there amongst clients and consultants as well as contractors (e.g. attempts to impose unreasonable risks, and a general tendency to adopt sharp letter-of-the-law practices). They could cope with these methods but firms from outside the wider London area, such as those coming down from the north, had their fingers burnt through not recognizing the different professional and business environment which now operates in and around London, in contrast to the more traditional one still operating in much of the provinces.

For firms used to operating in the wider London, onerous contract conditions proposed by clients do not seem to be more than a minor irritant. These can either be negotiated away, or in the present economic climate the firm can refuse to tender. Firms generally refuse to accept open-ended responsibilities for matters totally outside their control (sometimes their holding company will not allow them to do this in any case), although some firms maintained that they had a pretty good idea of the contract conditions which could be made to stick and those which could not.

Formal contracts have an important influence on communications within projects and almost all those interviewed said that their formal working communications were normally with the party with whom they had contracted. Where their contract was with the client this is often through the medium of the architect, especially where design is involved, and more occasionally through the medium of a construction manager.

A further issue raised was securing adequate and timely interim payment from contractors. This has never been easy; however, the general view in the interviews was that the position is generally better than in the past. To a large extent this is due to the specialist firms operating formal systems of credit control. Withholding of payment for alleged counter-charges, and a policy by contractors of 'pay-when-paid', were both the subject of criticism. Direct payment by the client is preferred, and many firms feel that this is the main advantage in contracting directly with the client.

There is an urgent need to return to a more orderly contractual environment. Too much time and effort is squandered on defining and redefining the industry's internal relationships. Clients have to pay for this and it is generally unproductive, even counter-productive. Building needs simple and clear standard forms of contract. JCT should investigate how its present family of contractual forms could be rationalized and simplified. All in the industry should actively encourage the production and then the use of a set of contract clauses which deal straight-forwardly with all clients' legitimate interests.

Once a contract is formed there are two main sets of relationships for specialists to manage. There is first establishing the design of specialists' work and secondly the interactions which take place during construction.

Design

In general all the specialists interviewed saw the architect as the ultimate authority on all design matters, even where innovative contract arrangements are used. Clearly architects must be responsible for the overall design of buildings. They determine the size, shape, overall configuration, arrangement of spaces and the performance of the whole building. However, the development of the overall design requires engineering expertise, and detail design increasingly requires collaboration between architects, engineers and specialist contractors.

The complexity of the overall design process, indicated in Fig. 5, is one area where major problems exist and where a solution is urgently required. The difficulty is basically a chicken-and-egg one. With the single exception of one firm, which because of its reputation and quasi-monopoly had a very secure client relationship, none of the firms interviewed was prepared to do more than the minimum design work required for tendering until they had a firm contract to carry out the work. In some cases where the tender design work had of necessity to be detailed they were not prepared to disclose the details prior to contract 'as it could be pirated by others'.

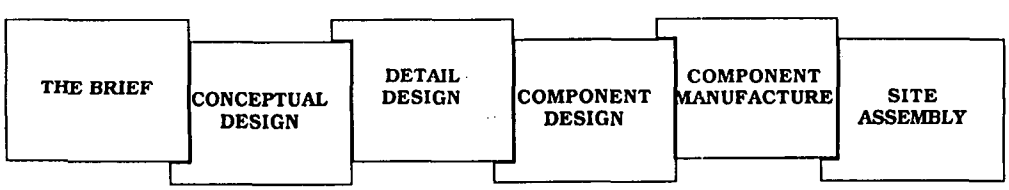

Fig. 5. Design, manufacture and construction process

Unfortunately, most of the problems (particularly those concerning the interface between the specialist work and the general fabric, or with other specialist work) only come to light at detail design stage. This means that problems have to be resolved in an *ad hoc* fashion and often require formal variations.

Although an agreement to pay for the specialist's design work if unsuccessful goes part of the way towards solving the problem, this solution was not generally looked on with favour since the firms stressed that their business was execution of work, and design was incidental to this. They did not want to become fee-earning consultant designers.

There is another side to the subject of specialist design. This is that many of the largest firms, especially those drawn from the rest of Europe, see design as part of their marketing strategy. These firms are prepared to provide design before any formal agreement has been reached. They rely on good, competent designers to get work and build committed long-term relationships with consultant architects and engineers. They build the costs of abortive design work into their general overheads where it is perhaps less visible to clients considering the different approaches. This is of course a point which worries consultant designers since they feel that their fees may be wrongly seen as a completely additional cost.

Design responsibility does not worry firms who have traditionally had a major design function (in fact some respondents maintained that they would like more responsibility rather than less, and would then be prepared to accept responsibility for 'fitness for purpose'). Such firms were able to get professional indemnity insurance relatively cheaply as part of their overall package of insurances, and none of those spoken to had a bad claims experience so far (nil in some cases). It was stressed that because of specialization they had much more technical knowledge and experience in their area, and in those other areas which impinged upon it, than had, say, an architect or construction manager. Therefore the chance of making serious mistakes is small.

Whatever contractual solution is adopted, the difficulty remains that some interface design depends upon the way other specialists detail their own work, so that any one solution is not valid unless other specialists' design is consistent with the preferred solution. Thus some form of two-stage selection and design seems to be necessary.

The complete integration of separate design contributions is further complicated by the varied demands of manufacturing. Some specialists require many months for the production of their materials or components to meet the demands of an individual project. Others can work to a much shorter time scale. The overall result is that design coordination is very complex both in terms of the performance of the finished building and in terms of the design, manufacturing and construction processes.

Specialists are often confused by the complex inter-relationships involved in modern design. With the result that amongst the firms interviewed, as far as design responsibility generally is concerned, although some firms wanted more design responsibility and others wanted less, their common ground was a universal dislike of half-and-half arrangements where responsibility was shared with the architect or consulting engineer. They felt that all too often they were being required to take responsibility for matters which were partly outside their control.

The practical reality is that designers must be 100% responsible for the overall design and specialists must be 100% responsible for the design of their element. This inevitably involves some degree of overlapping and duplicated responsibilities. However anything less than 100% responsibility tends to leave gaps in the resulting liabilities through which slip all too many of the problems and defects in finished buildings.

An important point raised by one of the architecture firms was that the worth of a specialist's guarantee of his finished work depends upon the firm remaining in business, whereas under present legislation the architect retains personal responsibility. An architect who has delegated his responsibility to a specialist could be in for a shock ten or twenty years later when something goes wrong and the specialist (together with his insurances) has disappeared. The whole question of liabilities is of course currently under review and not surprisingly the industry in the main favours clients insuring their building against defects. This approach in turn raises serious questions about the likely effects of such a crucial role for insurance companies. However, although the issue of liability was raised by those interviewed it is not a subject which centres on the role of specialists.

Finally, under the heading of design, almost all the specialist firms had a detailed information check-list for use at tendering stage, and another for use when the order was placed, and they maintained that they often had to exert a lot of pressure to get their questions answered (especially at detail design stage).

If such lists were published for major specialisms it would make it much easier for designers to programme and coordinate the provision of the right information at the right time. Research aimed at producing useful check-lists for at least the major elements and systems could make a valuable contribution to the industry's efficiency. A good starting point is provided by the check-lists in the *CPI, Project Specification, a code of procedure for building works* published by ACE, BEC, RIBA and RICS.

Site coordination

Modern procurement methods tend to give specialists increased responsibilities. Nowadays site coordination with other specialists is often a problem, especially where there is no general contractor or where the quality of site management below the level of the site agent is poor. It was consistently alleged that the quality of site management staff is often poor, and this can make all the difference to the specialists' profitability.

It was a common complaint that under construction management contracts, and to a greater extent under management contracting, the specialists are just thrown together and told to sort things out between themselves. This highlights a common misunderstanding. In the modern management-based approaches, specialists are required to coordinate their work technically and organizationally with that of the other specialists. On occasions this requirement has been wrongly interpreted by construction managers or management contractors as meaning that they do not have a detailed coordination responsibility. This mistake is commonly made by individuals with a general contractor background coming newly to a management-based approach. They see that the specialists are responsible for coordination and therefore produce an overall programme and budget and leave the specialists to work within this overall framework and resolve any difficulties amongst themselves.

In fact, of course, the benefits of management-based project organizations are realized only when the contraction manager or the management contractor works closely with the specialists in coordinating all their work. The requirements in specialists' contracts are designed to ensure their cooperation in this process not to relieve the construction manager or construction manager of their overall responsibility to do everything necessary to ensure timely and efficient construction. For this and other reasons (principally to do with payment

on a pay-when-paid basis) some of those interviewed were refusing to tender on management contracting projects, a luxury permitted by full order books.

However, there was another and interesting side to this coin. A few of the firms said they liked construction management, because once they were geared up to cope with its demands, relating mainly to paperwork and performance, they found that they were on elite tender lists where competition was less cut-throat and where payment (by the client) was more dependable.

Site meetings

Site meetings are essential for coordination purposes, but it is generally felt that these are badly organized (or indeed not organized at all). It was seen to be ridiculous that a senior person was expected to attend a lengthy (sometimes all day) meeting for the sake of a few vital minutes concerning his work. However, one firm which had experience of separate meetings to sort out specialists' problems said they preferred the 'old' system of plenary meetings. This is because it is easier to get at all the relevant facts about site problems when all those involved are sat around the table.

Clearly there is need for site meetings to be more purposeful. A definition of the specific aims of meetings, careful consideration of who should attend, positive chairmanship and proper records of decisions would all help specialists to carry out their coordination responsibilities.

Many management contractors are beginning to take management training for their own site staff very seriously. Some have invested in long-term training programmes in collaboration with appropriate university departments. A typical modern training programme might include the following elements over a six-month period:

Module 1	client's requirements, briefing, procurement options, marketing and communication skills
Project 1	prepare a marketing plan
Module 2	design and designers, quality assurance, negotiating skills, team building, leadership and motivation
Project 2	prepare a negotiating plan
Module 3	finance and cost management in major projects, value engineering, problem solving and project strategy

A further issue concerning work on site raised by many of the specialists interviewed was variations.

Variations

Dealing with variations contractually raises few problems for the specialists interviewed. However, the interruption to work caused by variations, or by what are seen to be inevitable site delays due to programme slippage, was a nusiance particularly to firms who were trying

to balance site demands with factory output. Because of this they had to maintain a fairly flexible response, and could not plan and manage their work as efficiently as they would like. They were realistic enough not to expect sites to become more efficient through any pressure from themselves, though it was stressed by the best organized of the firms interviewed, especially those with engineering backgrounds, that in their opinion most of the problems arose through poor management performance by general and management contractors. By way of explanation they contrasted the lack of formal managment education and training of contractors' managers unfavourably with that of their own executives. In fact there was considerable variation in the apparent quality of the managers interviewed. It must be concluded that there is a shortage of well-educated and trained managers in all sectors of the building industry.

Also it must be recognized that variations and altered programmes have many causes besides failures of management. Clients and designers often bear a large responsibility for complicating specialists' work. In part this happens because the costs of changes are not well understood. The penalties of working against the expectation of change can easily be of the order of 20–25% of total building costs. They are often much higher. Variations have been called the cancer of the building industry. They force contractors of all kinds to adopt flexible strategies and use organizations with low fixed-costs rather than allowing them to plan for efficient production.

Research is needed to identify the real costs of change. The results should help specialists resist the unreasonable, inefficiency-inducing stream of variations and programme alterations which they all too often face during construction.

Information technology

In the long run information technology is likely to influence all aspects of specialists' work including particularly its coordination with the work of others. However few of the firms interviewed made use of computers for anything other than routine payroll and accounting processes. Those making greater use of information technology are all involved in computer-aided manufacturing. These more progressive firms complained that it was pointless to develop computer working beyond their own internal processes, as few consultants and general contractors are equipped to handle electronic data transfer.

A major recent development is that FAX systems are universally used. It was generally felt that they had revolutionized the transfer of graphic information in particular, both within the firm itself (e.g. between office and factory) and in communicating with consultants. In the main the graphic information transferred by FAX consists of sketches which identify site problems and the subsequent answers. Further improvements in the quality of transmitted graphic information are necessary before working drawings are routinely transferred by FAX. As a corollary of the growth in the FAX, Telex is now little used.

Use of radio telephones and pagers was usually limited to car phones for a few executives, although one firm's site agents all had pagers. Only one of the firms interviewed, and that was a subsidiary of an overseas firm, made any significant use of radio links.

So modern information technology is only slowly influencing the work of specialists. Its use at present is limited by technical problems in handling complex graphical data and in incompatible computer systems. However it seems likely that intelligent communication

networks for building information would be set up if the computer systems which handle graphical data could be linked together easily. The benefits in offsetting the fragmented nature of the industry should be sufficient to overcome any organizational or contractual barriers.

It seems unlikely that the technical problems which currently inhibit the wider use of information technology can be solved by the building industry alone. There is a strong case for encouraging the setting up of multi-firm, multi-discipline working parties drawn from building and the electronics industries to formulate and implement policies for the application of information technology.

In addition to matters described thus far which relate to inter-firm relationships, there are important internal issues for specialists. These include quality assurance, training and research.

Quality assurance

There is a growing awareness throughout the industry that many clients want their buildings finished to a defined standard of performance. At present the reaction to this demand is muddled. This is reflected in the reaction of the specialists interviewed.

Many of them are implementing quality assurance (QA) systems reluctantly ('it is something that is bound to come'), or not investing in QA at all. They tended to see QA as merely generating yet more paperwork. On the other hand, those who had full QA procedures in use, find them to be of great benefit. They help internal control by replacing *ad hoc* arrangements with proper systems with the additional benefit that they satisfy client requirements. Generally QA systems are found to give better results at no increase in costs once the initial investment in systems and training has been made.

Some companies said they could recover any extra costs because being quality-assured put them on to 'elite' tender lists where profit margins are higher.

To some extent discussions of quality in building tend to confuse two separate matters. The first is selection of appropriate quality. That is the distinction between a Rolls-Royce and a Mini. Unfortunately the term quality is also used to describe standards of achieving the selected quality. Thus in this second use of the word we may have either a high quality or a low quality (meaning poorly constructed) Mini. Generally quality assurance is concerned with the second usage of the term. It would generally be more convenient to refer to this as performance assurance.

The suggested change in terminology may have important practical advantages. This is because while higher quality inevitably costs more, higher performance is very often associated with higher productivity, easier more controlled tasks for managers and, as a consequence, lower costs. By using the term quality for both situations, practitioners all too often confuse the separate and very different effects.

Well-developed systems of performance assurance are likely to benefit specialists' internal performance, may well serve in the immediate future to enhance their reputation and should help designers and construction managers integrate specialists' work into whole projects. The principles and practical implications of performance assurance are well known and so, given the clear benefit, an important task for specialists is to put performance assurance into practice.

Training

The emerging role of specialists requires a commitment to training on a substantial scale. Indeed it seems likely that in the future specialists will be primarily responsible for all operative training in building. In addition to this the need for management training was highlighted in the earlier section on site coordination. Taken together these requirements mean that training will be a key issue for specialists in the future.

At present commitment to operative training varies widely. Of the firms interviewed the majority take the development of their own employees very seriously indeed. This applies especially to those rooted in the engineering industry where good courses linked to structured training are widely available.

However, facilities for the training of specialist non-engineering, non-building-trade site operatives are poor.

The point was often made that lack of courses in areas of individual specialism makes life difficult, and this is accentuated by the CITB's alleged lack of interest in training people who are self-employed, labour-only sub-contractors. Since many of the firms employ their operatives on this basis, there is little or no training available for them. Firms pointed out that they had to pay a turnover-based levy, but got little in return.

Most of the firms who used self-employed labour made at least some attempt to train them. One firm had a formal arrangement of trainees, which it employed directly, working within self-employed site gangs.

Those firms interviewed who produce high-quality work in traditional craft areas take the training of apprentices very seriously, but some had to reduce their commitment because they found they were just training workers for other people.

Training of building operatives in the future will be very largely the responsibility of specialist contractors. It is appropriate to consider the matter in more detail. The following analysis is based on data provided by David Gann of the Science Policy Research Unit at the University of Sussex.

Responsibility for training in the construction industry is divided between the main statutory body, the CITB, and the non-statutory employer's associations (of which there are some 200, although not all are active in training). The CITB is supported by the major employers' associations because they recognize the fluctuating nature of employment, and the need for coordinated training to provide a skill base.

The largest problem facing those trying to maintain an adequate skill base has been a steady fall in the number of apprentices in the last ten years. The number of apprentices fell by nearly 20 000 between 1980 and 1984, from 69 000 to 49 200. In the electrical contracting industry, a massive drop from 4000 to 600 apprentices between 1979 and 1982, prompted the industry to adopt the Youth Training Scheme (YTS) in an attempt to encourage more firms to take on trainees, and to give more young people a taste of the industry. The number of NJCBI apprentices has also fallen steadily particulary after 1980. This is illustrated in Fig. 6.

Reductions in public expenditure have meant that the number of apprentices training in the public sector have also fallen, although the number was up slightly in 1985 and 1986, as shown in Fig. 7.

The main reasons for the overall reduction in training have been the downturn in workload coupled with the rise of self-employment. During the recession, training was cut by firms attempting to reduce overheads, there were fewer sites on which to place apprentices

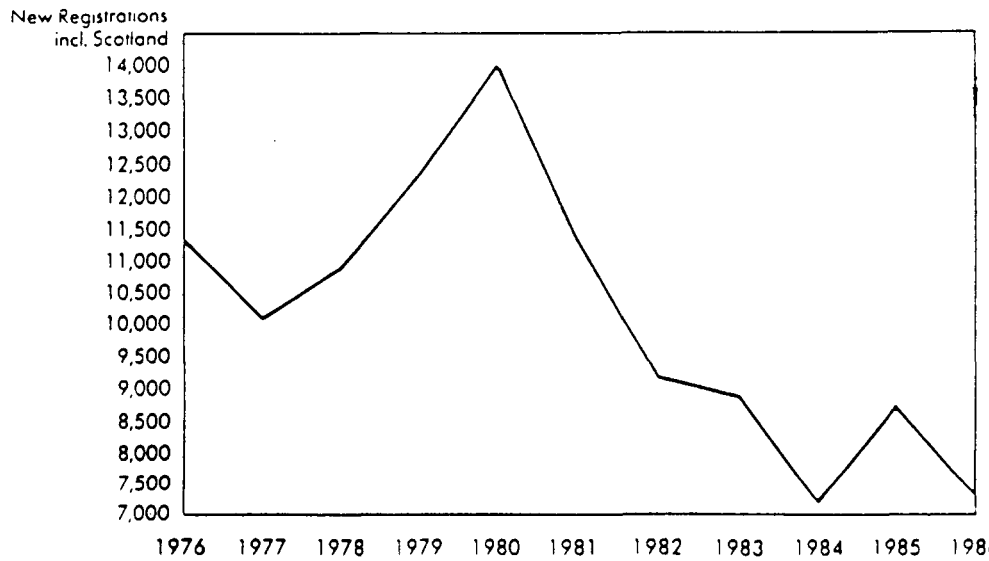

Fig. 6. NJCBI apprentices 1976–86

and the shedding of directly employed labour reduced the number of skilled workers capable of training apprentices.

Now that demand is growing, the poaching of skilled labour acts as a major disincentive to training. Once a firm not committed to training has acquired sufficient skilled labour, it may be able to undercut a firm that has higher overheads spent on training. Increased competition and lump-sum sub-contracting mean that many firms do not feel that they have time to train and retrain. Specialist sub-contracting may promote greater secretiveness between workers from different small specialist firms whose skills provide them with their competive edge. Thus there is a reluctance to cooperate in joint training schemes. The great mobility of smaller specialist firms also militates against firms taking on apprentices, because of difficulties and costs of travel. In order to change the attitudes of financial advisers on these issues, firms need to consider the cost-reducing benefits of training in the long-term, rather than see it as a loss in the short-term.

The CITB, recognizing some of these difficulties, set up action plans early in 1987 to tackle: shortage of craft operatives; adult operative training; and the provision of site management. As a result it is to provide an additional 3000 places/year on the two-year YTS scheme. It will

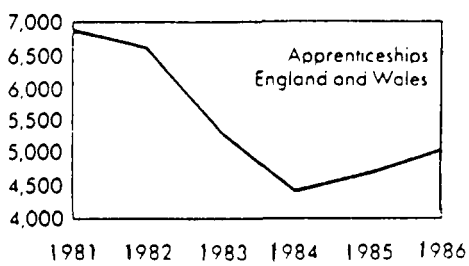

Fig. 7. Local Authority apprenticeships 1981–86

give grants for registration and skills testing for up to 10 000 trainees. The training of supervisers in small firms is to be increased from 1550 to 3000 by 1992. Financial support will be given to provide modular training in selected skills for up 1000 adults.

Problems in training can be placed in two categories: training new entrants and retraining existing workers. Firms tend to keep their most experienced operatives out on site continually, as the bread and butter earners. But this means that these experienced operatives may be the least likely to receive refresher courses, and new technology training. When an apprentice is placed, it is often with the more experienced operatives and therefore the apprentice may not gain knowledge of new technologies and practices.

A problem also exists with retraining and refresher courses. This is the problem of 'remembering-by-doing' where a trainee tends to forget what he or she has learnt unless they can practice the new skills soon after the course. This problem tends to be worse if the course is modularized over a period of time so that the trainee forgets the lessons from the previous module. Such difficulties can only be overcome through careful management both of training programmes and of subsequent hands-on practice.

The break-up of pair working and gangs, due to self-employment and specialist contracting, has diminished the opportunity for skilled workers to learn management skills on-the-job, and reduced the benefits of 'learning together'.

Finally, despite the CITB's efforts to bring training up to date, the training bodies lag too far behind changes and developments in the industry. This is partly due to the committee structure of the CITB, and the interests represented on the Board. At regional level, the responsiveness of the CITB depends to an extent on the attitudes of particular officers representing a region.

In the main, the CITB appears to be effective at providing training for the building trades such as bricklaying, carpentry and painting and decorating. But problems are apparent in areas where the adoption of new technology creates demand for new and/or different skills. This is particularly the case in some areas of mechanical and electrical work, which has become more specialized with the introduction of microelectronic control systems. Specialist contractors are experiencing problems in finding adequate new technology courses for their operatives. One of the major sources of complaint come from firms operating in the maintenance sector, where there is no appropriate training or career structure.

The current skills and training problems look set to worsen as the industry moves into a period of more sustained growth, and as major organizational and technical changes extend further across the industry. Technical change in construction will become more significant in the next 15 years, as firms gear up to reap the benefits of information technologies, and as the industry becomes increasingly internationalized (particularly under competitive pressures from Japan). Many of the changes in technology originate in supplier industries who often come into construction with their own workforce. This is particularly so where electronic components are concerned, and the entry of new firms may open up other parts of construction including maintenance, to future competition from such firms. These changes will bring demands for different skills, and different combinations of management expertise.

A further factor is that the skills required in repair and maintenance and new build will continue to diverge, with repair and maintenance requiring multi-skilled operatives, and new build a mixture of craft trades and specialists. As transferability of skills between the two sectors becomes more difficult, and as there is no adequate maintenance training, skill shortages and poor quality work in maintenance can be expected.

Most training effort is geared toward young people; however, the number of young people

is set to fall over the next 15 years, as can be seen in Table 1. Construction still has a poor image among school leavers and career advisers, and consequently it often receives school leavers with minimum ability. The industry is partly to blame for this image, and it must certainly do more to advertise its careers for promising bright young people.

Table 1. Projected population size for 15–29 age group

Year	Number (millions)
1984	13.3
1985	13.4
1986	13.5
1991	12.9
1996	11.6
2001	10.8

Source: *Social Trends* **18**, p. 24, CSO, 1988

But, while youth training is important in providing new generations of workers, the industry must look at ways of providing more facilities for adult training. It may not always be possible to provide adult training to full craft levels, but courses could be run to provide unemployed people with specialist skills (for example in fast-track work in Docklands) so that the indigenous population can be employed rather than bringing in workers from elsewhere. There is much discussion in the industry particularly between the Training Commission (previously Manpower Services Commission), CITB and firms in Docklands, over the possibilities of providing 'limited-skills' training. An example is training operatives to lay cable trays as a specialist skill, rather than using electricians on sites such as the Channel Tunnel or Canary Wharf, where miles of cable tray are required. This issue is very sensitive in the industry, and it requires very careful consideration before a policy is developed. One benefit could be that it would provide training for adults, but there are genuine fears that operatives may acquire some skills and then go and work on other jobs for which they are not qualified.

Given the changing picture of labour and skills in construction, there are a number of possible scenarios that the industry might follow. In the real world these options are never clear cut, and it is usually a mixture of several different courses that are adopted. But it is useful to consider hypothetical options so that the industry can attempt to follow a course of best practice.

(1) *Improve training*

This is the most desirable option. The industry should adopt a new approach to training and retraining so that its workforce is skilled in both existing and new technology areas. This requires that firms communicate their needs to training bodies and plan ahead for their future needs. Forward thinking is essential as it takes time to plan and instigate new training courses, and a number of years before trainees come into the industry. Training bodies need to be more responsive to the needs of new technology training, and the training of maintenance workers. They should respond to the problems of retraining and should

provide clearer direction on the industry's skills problems. Lessons may be drawn from a comparison with training in other countries. In France half the young people entering construction do so after full-time schooling in building trades between the ages of 14 and 17, and excellent workshop facilities are available. Training in both France and Germany is geared towards greater breadth so that an opearative will be better equipped to cope with technical changes. A radical approach for the future would involve the CITB providing training for basic building crafts (which they are good at), and then providing a core 'building operatives' training in a number of areas, from which operatives would then go on to learn specialist skills with a firm, on modular courses developed by a more responsive CITB. Such core areas might include maintenance, mechanical, electrical and specialist fixings.

In planning for the future, it must be recognized that technical change in engineering services is occurring at a much faster rate than in many other areas of construction. It is therefore important that engineering services operatives are able to maintain their skills through retraining with flexible modularized programmes.

2. *Develop simplified technology*

When skill shortages persist, firms may attempt to develop technologies that can be installed and operated by less skilled workers. This may be the case with building management systems where supply firms are attempting to simplify the technology. In some cases where problems continue, there may be a move away from that type of technology, because skills are too difficult to find. However if a technology is developed so that less operative skills are required, the managment function usually increases (e.g. in fast-track construction). It should be noted that the use of simplified technology may require a high degree of technical knowledge, and it cannot be used as a direct substitute for skilled labour (for example, the problems with timber-frame house construction in the early 1980s). Therefore greater emphasis will be required on getting the management skills right.

3. *Import key skills*

When skills are essential, but cannot be found in the local labour market, they may be imported from elsewhere. Recently, workers from the North (Liverpool, Leeds and Scotland) have been recruited to work in London and the South-East. Anecdotal evidence suggests that a large number of workers are now making the trip to London. However, problems of accommodation, transport, and family separation raise questions of the desirability of using imported labour, especially in areas such as Docklands where there is unemployment amongst the indigenous population. It is likely that this source of labour supply will dry up if the demand for construction continues to grow in other parts of Britain. The industry will then have to search further afield for its labour. The use of foreign specialist skilled labour is already evident on some sites in London, and sub-contractors are actively seeking general labour in Europe. This has three negative consequences for the industry. It further erodes training and the provision of a skilled base. It may open up the British industry to increased international competition, providing foreign firms with a toe hold in the British market. It may also push up the cost of construction.

There are several large projects, for example the Channel Tunnel and Canary Wharf, that will require a huge supply of labour in the near future. The maintenance of existing buildings, often with more sophisticated services, requires a constant supply of highly trained

engineers – the Channel Tunnel will require some 500 maintenance engineers alone (private source). The industry still has the opportunity to plan for this supply by increasing training and tackling some of the problems such as self-employment, which have hindered training. Failure to do so may leave construction significantly short in all skill areas in years to come, and open the door to increased international competition.

Research and development

Research and development into individual building elements and systems will increasingly be the responsibility of specialists. At present there is little evidence that the need to invest in future technology is recognized and accepted. Amongst those interviewed only three firms claimed to be doing any research and the most committed reckoned that only about 1% of turnover was spent in this way. This is extremely worrying in terms of sustaining an effective and profitable building material and component industry into the next century.

There are also research and development issues for the rest of the building industry which arise as a direct or indirect consequence of the emerging role of specialist contractors. Some of these have been identified in the earlier sections.

One important issue thrown into sharp relief in this way is the need to research the behaviour of whole buildings. We do not have a good understanding how whole buildings behave, so services, for example, become ever more complex as each internal comfort problem – condensation, energy use, ventilation – is tackled individually on an *ad hoc* basis. Another system or more expensive, clever equipment is added to tackle each separate problem. But no-one knows how all this technology behaves as a total building system – and so there is duplication and waste and we get problems like the sick-building syndrome.

Closely linked to the need to research the behaviour of whole buildings is the need to understand how people's behaviour and performance is influenced by buildings. This research is necessarily large scale and expensive but the benefits in improved health, productivity and general happiness are potentially massive.

Evaluation of specialists' proposals

A second important research and development issue is the evaluation of alternative proposals submitted by competing specialist firms. As detailed technical knowledge increasingly resides with specialists so it is likely that performance specifications will be widely used in inviting tenders. This faces clients, designers and construction managers with the task of evaluating alternative designs, prices and times. To do this properly is expensive.

The problem is evaluating different combinations of design, price and time. If schemes are invited from say three contractors, you may well get a result like this:

	Contractor		
	A	B	C
Design	1	2	3
Price	2	3	1
Time	3	1	2
Total	6	6	6

The proper way to handle competition which includes a design element is to state the client's priorities and evaluation system in the invitation to tender. Thus the weightings for one project might be: design 5, price 2, time 3.

The invitation to tender should also state how each of these factors are to be evaluated.

Given the stated weightings the earlier results become:

	Contractor		
	A	B	C
Design	5	10	15
Price	4	6	2
Time	9	3	6
Total	18	19	23

and a clear winner is identified.

The great advantage of this formal approach is that the contractors know where to make their effort – in this case on design rather than price reduction. They also know that in this case speed is more important than low cost.

However, setting up and operating a rigourous evaluation system needs research to identify the important criteria and effective evaluation and weighting systems.

These examples of necessary industry-wide research serve to illustrate the need for research at two quite distinct levels. Specialists need to understand and develop their own elements and systems. However, equally designers and construction managers need to develop their understanding of buildings as complete social-technical systems. The two levels provide very different subject areas, each requiring different knowledge, skills and research methods.

A single market in Europe

The European Community intends, by 1992, to remove all trading barriers and so turn Europe into a single market. This will increase Britain's home market from 55 to 320 million people. There will be many important consequences for the building industry. Two in particular are worthy of mention in this review of the position of specialist contractors.

First there is a strong link between the size of the biggest contractors and the size of their home market. There is therefore an opportunity for spectacular growth in the next few years. To accompany this there will of course be increased competition from European specialists.

The second interesting effect of a much larger home market for British specialists may well be a change from specials to standard products. This is because Britain's present relatively small home market provides only marginal cost advantages from the use of standard products. For many elements and systems it is little more expensive to use individually designed products. This is in stark contrast for example to the USA where standards are very significantly cheaper than equivalent bespoke products. A European home market of 320 million people may well provide the basis for low-cost, yet sophisticated, high-quality standard building components.

Thus there may be at least two very important effects for specialists from the creation of a single market in Europe. Since 1992 is already close, specialists need to understand Europe as their home market so as to learn who their main competitors are likely to be and where the opportunities will be.

Conclusion

Specialist contractors are major actors in the building industry. Their role and their interests need to be given equal consideration by all policy makers to that currently devoted to designers and construction managers. Specific needs are identified in each of the sections of this report. Taken together these detailed needs demonstrate that contemporary research issues are mostly concerned with interrelationships between separate organizations, that is with boundary control rather than with the operating core of individual firms. This is true both for management and technology.

As we have seen the key management research issues include:

(1) identifying the essentially different roles which specialists need to undertake in order to satisfy the many different demands of today's building clients,

(2) identifying and evaluating the effectiveness of the kinds of boundary control processes which exist in practice in building firms of all kinds,

(3) providing greater clarity and consistency in the definition of roles and responsibilities in management-based procurement approaches,

(4) encouraging the production and use of a simple set of contract clauses which deal straightforwardly with all clients' legitimate interests,

(5) producing detailed information check-lists for the major elements and systems,

(6) improving site coordination especially through studies aimed at making site meetings more purposeful,

(7) identifying the full costs of variations and programme alterations especially taking into account the disincentives to planning and programming created by a widespread expectation of change,

(8) encouraging multi-firm, multi-discipline working parties drawn from building and the electronics industries to formulate and implement policies for the application of information technology.

All of these potential research topics concern relationships between firms in the industry. Research issues arising from the modern role of specialists which need to be dealt with by individual firms include:

(9) putting performance (quality) assurance into practice,

(10) increasing training to provide all the skills needed in the industry,

(11) identifying rigorous evaluation systems for competitive design options,

(12) understanding the behaviour of buildings as complete social-technical systems.

Finally, there is also the over-riding need to take research and development more seriously. This applies to specialists just as much as to the rest of the building industry.

Appendix: Size and structure of specialists interviewed

Thirteen sets of interviews were carried out with specialist contractors as follows:

Lift firm,
Stonework firm,
Suspended ceiling firm,

Joinery firm,
Metal window firm,
Engineering services firms (2),
Roofing firms (2),
Curtain walling firm,
Access floors firm,
Architectural metalwork firm,
'Intelligent buildings' firm.

All these firms, with the exception of the metal window firm, were based in the South-East of England. All but four of them were based outside London, but most had experience of working there.

Ten of the specialist firms interviewed formed part of a larger group. Of these:

Two were UK subsidiaries of overseas companies in a similar line of business,
Two were subsidiaries of a UK construction group,
Four were members of a group of associated companies in the same line of business,
Two were subsidiaries of a major UK engineering group.

Many of the firms traced their origins back a very long way, the oldest established being started in the 18th century. Only one was less than 20 years old, and this was by far the smallest.

By far the largest of the firms in terms of turnover was an engineering services firm with an annual turnover of £125 million, the second largest having a turnover of £45 million. From here the figures graded down fairly evenly to the smallest, a roofing and cladding firm with a figure of £0.5 million. The median figure was £10–£15 million. Similarly the number of employees varied from 1690 down to 4 (median 140–200). However, some firms had all their site work carried out by self-employed labour not included in the above figures.

Where the design staff could be separately identified they did not form a large proportion of the total. The largest proportion noted was at the architectural metalwork firm (15%); nowhere else did it exceed 10%.

Very often the highest proportion of staff were factory workers.

Every one of the firms said that 95–100% of their trading took place within the context of the building industry.

The majority of firms felt that each new project was essentially different. Only a few thought that work was always much the same – none of these had a traditional building industry background.