

# *Construction industry: Historical overview and technological change*

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# **CONSTRUCTION INDUSTRY: HISTORICAL OVERVIEW AND TECHNOLOGICAL CHANGE**

The construction industry comprises all those organizations and persons concerned with the process by which building and civil engineering works (following the activities listed in the International Standard Industrial Classification (ISIC)) are procured, produced, altered, repaired, maintained and demolished. This includes companies, firms and individuals working as consultants, main and subcontractors, material and component producers, equipment suppliers and builders merchants. The industry has a close relationship with clients and financiers. This definition was the result of discussions at a conference organized by the International Council for Research and Innovation in Building and Construction in 1999.

The industry encompasses various parts:

- **Housing:** The fundamental need for shelter is one of the basic driving forces that leads to the development of a building industry, but housing usually remains a specific sector, financed and organized differently to the rest of the building industry.
- **Building:** The development of settlements, villages and towns involves the construction of shops, schools, offices, factories, warehouses and so on. Buildings generally require diverse components and materials and a large number of specialized crafts.
- **Civil engineering:** In the Middle Ages the engineer was a military man. In the UK it was with the development of the canals that the profession of civil engineering was

developed. Civil engineering projects tend to involve vast amounts of earthmoving by men or machines and a small number of large scale activities. They include canals, roads, airports, dams and irrigations systems.

- Repair and maintenance: The output of the construction industry requires repair and maintenance otherwise it will degrade. Indeed, repair and maintenance usually represents approximately half of construction activity for most developed countries.

## **WHAT THE INDUSTRY PRODUCES**

### **Pre-industrialization**

The products of the industry from earliest times are closely related to the availability of local materials. Originally settlements were formed for common protection against wild animals and for mutual help. In the early stages of development, most projects were for the provision of simple buildings, housing, small workshops and farm buildings.

Settlements developed into villages, and later into towns and cities and buildings became more sophisticated, and generally of higher quality and more durable.

Building was done by the members of the community, and this informal approach to construction survives to the present day, in the shadow of the formal industry. The building industry developed as towns were established. Susan Reynolds describes the characteristics of a town as a settlement where a significant proportion of the population lives from trade, industry and administration forming distinct social units, separate from the surrounding countryside. The development of towns also led to the need for transport and communications, requiring roads, bridges, harbours and ports.

The earliest great buildings, where longevity and prestige were important, were made of large blocks of stone, sometimes transported over enormous distances, for example, Stonehenge, the Pyramids and more recently castles and cathedrals. Interestingly, Louis Francis Salzman describes how “the building of a church might be spread over generations, but a castle would be of little use if not completed with the utmost rapidity...”.

The building industry tends to use locally produced materials and products, even in Europe, partly because of the cost of transport, but in developing countries locally produced materials are the norm. In tropical developing countries one of the materials used for housing is woven coconut palms and in the Nile delta, the traditional building material until well into the 20<sup>th</sup> century was Nile mud. In temperate climates, timber is a much used material and, where it has been available, stone, followed at a later stage of development by clay products such as bricks and roof tiles. One key feature of many of these materials is that they can easily be replaced or are so robust that they can be re-used. It is not unusual to find ruins being used as a source of building materials.

Wherever trees grow, they have been used for timber. Timber was very widely used for cheaper construction and for small scale construction. Compared to other materials it is only moderately strong, but it is easier to work than the stronger materials. But its greatest disadvantage was its flammability, leading to many famous great conflagrations. During the 20<sup>th</sup> century, developments in fire retardants and glues led to a more widespread use of timber in many circumstances.

## **Post-industrialization**

As industrialization develops, there is an increasing need for large robust buildings for industry. Factories, warehouses, offices and shops are all a consequence of industry and commerce. Thus, the emphasis in a country at the early stage of development is on factories and works and later on commercial rather than residential buildings. As populations move to meet the needs of industry and commerce, a mass market for housing develops and, as wealth is created, there is a need for more prestigious and substantial buildings. At the same time, and partly as a result of these demands, new materials and composite materials such as reinforced and pre-stressed concrete enable designers and builders to meet these needs with innovative solutions.

Despite the early and diverse use of iron, particularly for nails, as far back as the Middle Ages and steel for specialist items such as the hard edges of tools, iron was rarely used as a major building material until the building of structures such as Ironbridge in Shropshire, UK, (1777-8), Crystal Palace, for the Great Exhibition in London (1851) and the Eiffel Tower for the Paris Exhibition (1889). However, the impact of iron and steel on the construction industry was most significant after the development of processes that enabled vast quantities of steel to be produced cheaply and of consistently high quality. Thus, in the UK, it was not until the late 19<sup>th</sup> century that major use was made of steel as a structural material. In places like Chicago, this enabled the development of much higher buildings than had previously been built. For example, the 16-storey Monadnock building of 1891 was an office block with load-bearing walls of brick that were 6 feet thick at the base. Much thicker than this and there would be no space between the walls. The limit had been reached for load-bearing masonry construction. But at the same time,

many buildings in American cities were already being built using a skeleton steel frame construction, leading eventually to much taller buildings, with usable floor area at all levels. As a result of the Great Fire of Chicago (1871) in which most of the buildings in the central business district were destroyed, and with easy access to steel, Chicago became the birthplace of modern architecture. Hugh Dalziel Duncan points out the significance of the fact that the new buildings of Chicago were not built by the city, by religious organizations, by educational institutions, or by private groups as palatial edifices: they were built by businessmen and they were built for profit.

Reinforced concrete frames also emerged, the earliest example of which is the Ingalls building in Cincinnati, completed in 1903. By combining the compressive strength of concrete with the tensile strength of steel, and casting shapes on site, large, strong and complex structures are possible. To increase the load-bearing capacity of reinforced concrete, the technique of pre-stressing involves stretching the reinforcement before pouring the concrete, so that once the concrete is cured, the steel puts the element under compression, thus enabling much greater load-bearing capacity.

It is important not to underestimate the impact of major items of equipment, such as cranes, concrete batching plant, and various handling and lifting machinery on building sites, as well as earthmoving machinery which enabled the construction of airports, roads and harbours.

The widespread use of steel and concrete in structures depends upon the availability of a transportation system that enables the delivery of bulky materials to their point of use. Thus the development of railways, canals, roads and shipping is a prerequisite for the development of a modern construction industry (*see also, Transport*).

The developments in the use and availability of steel and reinforced concrete were probably the most important developments in building materials. But modern buildings are possible because of equally innovative developments in the production of glass walling, windows, elevators, heating and ventilation.

## **Pre-fabrication**

Pre-fabrication refers to the practice of manufacturing products off-site, in a controlled environment, and then delivering them to site for installation. It is used widely in the construction industry in order to locate the production process away from the unpredictability of conditions on the building site and bring it into an indoor environment. In temperate climates, this can reduce the impact of bad weather. But, regardless of climate, pre-fabrication usually allows for better supervision and, therefore, quality.

## **Buildings**

Pre-fabricated buildings are rarely whole buildings transported to site, simply because of the size of buildings. In trying to meet as quickly as possible the huge demand for dwellings in the UK during and after the Second World War, “pre-fab” houses were factory-made, delivered in flat-pack form, then fastened together on site and placed on a concrete slab. In order to create heavier buildings, pre-fabrication has tended towards the manufacture of modular items that can be bolted together on site, and this is more often called industrialized or system-building. The aim of this kind of pre-fabrication is to reduce, but not eliminate the need for above-ground site work and, by reducing the need for skilled site labour, to increase the capacity of the industry to construct dwellings



quickly. The development of large apartment blocks in various European cities, such as those in Paris and Moscow, was based on the use of various types of prefabricated modules. These practices were clearly very widespread. They have also produced buildings that are rarely liked. However, the techniques continue to be used with some success. Indeed, in Japan, Toyota has produced dwellings using techniques similar to those used for the manufacture of cars. If all the apartments occupy the same space, then a consumer need only make a choice from a limited range in a catalogue. While system-building is aimed at producing whole buildings, the principle has also been applied to components of buildings, for more general use.

## **Components**

The pre-fabrication of components has become one of the most important means for making the construction industry more productive. Factory-made window frames and door sets reduce the demand for joiners on building sites, as they can be installed by semi-skilled operatives. Similarly, heating and ventilation equipment can be designed to be centralized into one or more large boxes that can be factory made, delivered and installed as a unit. In office buildings, the toilets can now be produced as “pods” that are completely finished inside, requiring nothing more than locating and connecting to the electricity, waste and water services.

One essential aspect of the increasing use of components is the development of modular sizes. Modularization has made it much simpler to select components for use in all sorts of buildings because there is some conformity of size between various manufacturers. In the USA, where factory-made components seem to be more widely used than anywhere else, designers can choose from a very wide range and catalogues are produced with part

numbers and supplier details. The practice here is very close to designing by assembling “kits-of-parts”.

## **Sophisticated civil engineering projects**

Major civil engineering projects are not just a feature of the modern world, as the Seven Wonders of the Ancient World attest. In addition, the Great Wall of China, an enormous feat by any reckoning at 6,400 km long, was commenced in 7<sup>th</sup> Century BC and was built over a period of some 2,000 years. Hill forts were built in the UK well into the Iron Age. The need for water has often been the motivating factor behind great feats of civil engineering. The Romans were accomplished engineers and builders. One famous surviving example is the France’s Pont du Gard, built in the 1<sup>st</sup> Century BC, to bring water to the town of Nîmes. On a much larger scale, in Sri Lanka, irrigation reservoirs, called ‘tanks’ were created. From AD 274, the great tanks were built and are still in use, the largest of which is a reservoir of 4,670 acres.

The difference between historical and modern civil engineering projects, then, is not a difference of scale or of vision. In the UK, Thomas Telford (1757-1834) designed and supervised the construction of the Menai Strait suspension bridge, opened in 1826, supporting a span of 579 feet between the towers. The designs in modern civil engineering projects involve mathematical calculation, intensive use of plant and machinery as well as modern materials. An example is the 31-mile Channel Tunnel, joining England to France by rail, up to 131 feet below the sea bed. This involved enormous purpose-built tunnel boring machines that started at opposite ends and were navigated with great precision towards each other.

## **Quality, durability, longevity**

There is wide variability in expectations of the life of buildings. In the UK, 60 years is not an unusual life expectancy for a building, although about 15% of the current housing stock is over 100 years old. By contrast, the Japanese use 20 years as a typical life expectancy for a dwelling but usually they last for 40-60 years. The difference in longevity may be due simply to the fact that in the UK, the stock of dwellings is predominantly of brick and masonry, whereas in Japan, timber is more usual for dwellings.

The quality of work in the construction industry is variable. The work is largely bespoke, site-based and geographically dispersed. No trade can be continuously employed on one site, so there is disruption as labour moves from one site to another. The industry has characteristics that make consistency of output difficult to achieve. Moreover, much of what is built is produced in response to particular markets. Some customers of the industry are either unwilling or unable to pay for high quality. Further, the way that a building is designed and supervised has a significant impact on the quality of the product.

Old buildings that have survived are not typical. There is no reason to suppose that buildings used to be of a higher quality, or longer lasting, generally. We see only those that have survived and the vast majority did not.

The industry is very skill-intensive and although the move of some of the processes into factories has reduced the need for some skills, there is still a pressing need for skilled and experienced operatives, the shortage of which is a perennial problem everywhere.

## **Repair and maintenance in relation to size of stock**

The need for repair and maintenance increases as the stock increases but it is common for this need to be overlooked. Most developing countries neglect repair and maintenance to the detriment of the stock. The planned economies of the Soviet Bloc had no adequate provision for repair and maintenance. As a consequence some of the buildings are beyond repair. In developed countries, approximately half of the activity of the construction industry is repair and maintenance, but there are problems even with assessing how much work is done in this sector, not least because much of it takes place informally. Indeed, in many countries there are no statistics collected for construction repair and maintenance.

## **RELATION TO THE ECONOMY**

### **Economic characteristics of construction**

The construction industry is vital to the national economy. It produces on average across the world around a tenth of all the goods and services produced. Just as important is that it produces about half the investment which is essential to the present and future well-being of the economy. Governments are major influences on the construction industry because they control the economic parameters in which the industry works, such as the rate of interest and the system of taxation. In addition governments and other public sector agencies are clients for much large building and civil engineering work. These characteristics provide the key to the interrelationship between the industry and the economy. The sheer size of the construction industry and the investment goods it provides mean that changes in output affect the size of the national product both directly

and indirectly but it also means that what is happening to the construction industry must be a matter of national concern. It is too big and too important to ignore.

## **Fluctuations and their effects**

### **Fluctuations in demand**

The characteristics and behaviour of the construction industry have been similar throughout history. Even in the Middle Ages there were substantial fluctuations in output and these continue to the present time. The key to this lies partly in the nature of investment goods:

- The value of the product is high in relation to the income of the purchaser.
- In many cases, the product is required not for its own sake, but for the flow of services which it generates e.g. factory building, living accommodation, or transport and communications.
- The products of the construction industry have a long life and the stock is therefore high in relation to annual production so that small fluctuations in the demand for the stock of buildings have large repercussions on the demand for new building.

Another reason for fluctuations in demand is that most of the products of the industry will be required only if certain other factors are favourable, for example, the level of demand in the economy as a whole, the availability of mortgages for house purchases and the economic climate in which government takes decisions about the level of social services. The dependence on government as a client means that it is able to increase or reduce the demands on the industry by actions on its own proposed projects, in addition to the

indirect control it is able to exert on overall investment through control of credit and interest rates.

Construction contractors rely on work other than competitive contracting to balance fluctuations in demand. Historically, their efforts were directed to controlling their supplies by building up large skilled and unskilled labour forces, and owning their own plant.

Overall demand for certain types of work changes due to the state of the economy. This has effects upon the diversification policy of companies which are particularly susceptible because of low profit margins and the importance of cash flow. Such fluctuations lead to insolvencies in construction companies.

### **Seasonal fluctuations**

Seasonal fluctuations are caused by weather patterns and by the demands of other activities, like agriculture, especially in less-developed countries. Regardless of economic cycles, the construction industry has always been subject to seasonal cycles. Fewer customers want to build in the winter than in the summer. Moreover, certain construction operations are susceptible to inclement weather, making construction longer and more expensive in the winter. Various ways of overcoming these problems have been in operation throughout history. For example, in Ancient Egypt, construction work on pyramids was dovetailed into the agricultural seasons. Similarly, in England for many generations, the builder was often the undertaker and sometimes also the coal merchant. The demand for building work was lower in the winter, but the death rate was higher and the demand for coal greater so that fluctuations in overall workload could be ironed out.

This applied throughout the trades because masons could be used for gravestones as well as building, joiners could be used for making coffins and the builders had a yard for storing coal and carts for funerals and fuel deliveries.

### **Fluctuations in work flow**

The volume and type of work change during the execution of any project. The demand for labour fluctuates during the process because, for example, excavation and foundation building require very different skills and materials to roofing and finishing. This kind of fluctuation can be smoothed out if a contractor has a very large flow of work, so that operatives can be moved from one site to another. However, if there is little work, or if the projects are widely dispersed geographically, other solutions are employed.

Typically, work is sub-contracted to local specialists. For these reasons, general contractors are either very large, (such as the big six in Japan) or they sub-contract the majority of their work as is now general practice in the UK.

### **Government intervention**

Although the construction industry has a substantial impact on the health of the economy, governments have not attempted to influence its effect until relatively recently. In general, when they have commissioned work they have acted solely for the successful completion of that particular project. In 1253, as Salzman reports, Henry III wrote to his treasurer and his Clerk of Works “we command you as you wish our love towards you to be continued, that you in no wise fail that the chambers which we ordered to be made at Westminster for the use of the knights be finished on this side of Easter, even though it should be necessary to hire a thousand workman a day for it”. The English kings even

resorted to pressed labour, on pain of imprisonment. This is a clear example of the way that clients and governments have historically focused on the industry's products without understanding any effects of the industry on the economy. This changed during the 20<sup>th</sup> century.

Because the construction industry plays such an important part in the economy, its activity is affected by government plans for national development. Although various governments have attempted to develop their construction industries, few have done it seriously or with much success. For example, Nigeria's national plan included the construction industry and Singapore established a Construction Industry Development Board. Most countries in their development plans consider the building of infrastructure without considering the impact on the construction industry or how the construction industry might be able to respond.

The 20<sup>th</sup> century has seen the emergence of international bodies with an interest in development. Agencies such as the World Bank, the European Bank for Reconstruction and Development, the Asian Development Bank and EU Programmes frequently commission capital projects as a catalyst for development. Some of the practices of these agencies are out of step with modern thinking. For example, World Bank projects often have too many tendering contractors by today's standards. Moreover, the size of project is so great that it excludes the participation of local contractors and does not consider the impact of the method of organization of the contract on the local construction industry.

Also governments have played a major role in the planning and in the regulation of the quality of buildings, particularly in response to disasters. For example, the Great Fire of London in 1666 led to legislation about party walls between dwellings; a similarly



destructive fire in Chicago in 1871 and earthquakes and other disasters frequently lead to revisions to building codes and regulations (*see also, Regulation*).

## **Activity related to development**

In terms of economic development, the demand for durable and high quality buildings only arises once the basic needs for life are met. Thus, less-developed countries have a low demand for the products of the construction industry as a proportion of their income. As a country industrializes, the demand for construction accelerates rapidly. But in advanced industrialized countries, it declines. Once the stock of building is sufficiently high, the need for new construction tails off but the need for repair and maintenance and for rehabilitation increases, according to Ranko Bon and David Crosthwaite.

## **HOW THE INDUSTRY IS ORGANIZED**

### **From crafts to trades and professions**

Specialization in the labour used in building began very early as those undertaking building work were found to be particularly good at certain tasks. Monks building their early churches in wattle and daub and thatch would have done the work themselves. But when the more difficult task of masonry arose, the monks would have done the simpler work but lay craftsmen performed most of the work. In Europe the earliest crafts were the masons, who were divided into various specialist skills, and the carpenters. Other crafts provided more specific parts of buildings, such as tilers, slaters, thatchers, plumbers, glaziers, smiths, painters, plasterers, and later bricklayers etc. In England specialist craftsmen organized themselves from the beginning of the 13<sup>th</sup> century in a

system of craft guilds. They were strictly local and, in general, membership of one town's guild did not confer membership of another. This was not suitable for masons who were constantly on the move and they formed "lodges" or temporary associations where they worked. This division of crafts remains similar today and applies over large parts of the world.

Louis Francis Salzman documents the development in the UK of architects from master masons and carpenters of the 14<sup>th</sup> century to independent designers of buildings who eventually became more closely associated with architects from a more artistic background such as Sir Christopher Wren, the designer of St Paul's Cathedral in London. In the UK, the role of the modern architect was crystallized with the formation of the Royal Institute of British Architects in 1850. In this role, architects took charge of the whole process of ascertaining what the client wanted, designing the building and supervising its construction. Christopher Powell explains that the new profession of quantity surveyor (measurer) began to emerge in the 1820s. Their role was concerned with cost prediction, dealing with bidding and measuring work in progress for the purposes of interim payments. Over the last few decades, many more specialized roles have emerged, such as project manager and construction manager, and a comprehensive description of the full range of roles has been provided by Will Hughes and John Murdoch. Although many of these practitioners have their own associations, they have not achieved the status of separate professional institutions as the role is often filled by members of the existing professions.

In many countries, particularly those not influenced by British practice, the development of the role of the architect has not been as significant as that of the engineer in forming the modern construction industry.

While the crafts were developing, self-build was continuing, particularly in rural areas. The habit of repairing and maintaining one's own property has led to a substantial DIY (do-it-yourself) industry, particularly in the UK but increasingly elsewhere.

While it was originally the practice for the client to employ each of the necessary crafts directly, some master masons and carpenters took the step of taking responsibility for the whole project and employed their own tradesmen so that they could operate as building contractors. In this situation, the early contractors were able to provide the design and the construction as required, but they were often employed to build only a part of a project, alongside other contractors and tradesmen employed by the client. In some contracts the builder was called upon to supply materials, but in others the employer provided them. During the centuries prior to industrialization, practices were clearly very diverse.

In the UK, during the industrial revolution, general contractors emerged. In one of the few detailed historical studies of building contracts, Richard Moore describes how Thomas Cubitt in London began to trade as a general contractor in the early part of the 19<sup>th</sup> century and this is usually acknowledged as origin of general contracting. Prior to this, it was the usual practice for tradesmen, such as carpenters, to sub-contract their work to others. Cubitt employed all the craftsmen he needed and paid them regular wages. In order to sustain this labour force and pay for yards and business premises, the peaks and troughs of contracted work could be smoothed by speculative house building. In the 20<sup>th</sup> century, contractors continued the practice of speculative house building for two further

reasons: first, to invest surplus cash in land and second using the positive cash flow from contracts to finance the building of houses. These days, there is a growing tendency for contractors to use their positive cash flows to invest in projects, rather than house building. This investment comes about when governments encourage the use of private sector capital to procure public services, known variously as Private Finance Initiative (PFI), Public/Private Partnerships (PPP) or Build, Own, Operate and Transfer (BOOT). The financial structure of contractors is, therefore, very complex and has led to the development, particularly since the Second World War, of large building and civil engineering contracting organizations. Most countries have major contractors, many of whom operate internationally, but recently, through mergers and acquisitions, some of these now have an annual turnover larger than the GDP of many small countries, for example Skanska, Dragados and Turner. However, major contractors may have an unexpectedly small workforce, because large portions of their work are sub-contracted to others. The largest construction giants are actually conglomerates with a number of different business types contributing the group's profits. This may include not only construction activities, but design consultancy, service provision, as well as investment and property development. The most recent developments in the way that contractors have diversified and formed into groups are merely the latest step in a long history during which successful contractors have sought to engage in business activities whose cycles counteract those of building.

Sub-contractors have always been a feature of the construction industry. Since mediaeval times, it was quite normal to encounter both labour-only sub-contracting and supply-and-fix sub-contracting. In the former, materials are supplied and the sub-contractor provides

only the labour. In the latter, the sub-contractor provides the materials and components. Even when general contractors have a large workforce, they still sub-contract specialist items of work and use sub-contractors alongside their own workforce to deal with peaks in demand. It should be noted that labour-only sub-contracting is frowned upon in some countries; for example, in some circumstances it is illegal in France and Germany.

General contracting of the kind where the contractor employs most of the workforce is a relatively recent phenomenon and it is no surprise to see a trend over the last few decades away from direct employment towards sub-contracting. In construction, therefore, it is extremely unlikely that there would be a direct relationship between volume of business and size of workforce. But most firms in the construction industry are small. This is because of the size and geographical distribution of projects, including repair and maintenance. Numerically, most of the jobs are small. Even large projects lead to many small contracts because of sub-contracting. Apart from planned economies, this size distribution of contractors is virtually universal: in just about any country, there is a handful of large companies and a huge number of small ones.

One of the features of many construction industries is that contractors need very little capital because payment is usually made for work in progress, often on a monthly basis. At the same time, they are often able to delay payments to their suppliers and sub-contractors until after they have received payment for work done each month. In this way, construction contracts are cash-positive throughout the building period and successful contractors can invest surplus cash for the duration of a project. Competition for work is frequently based on lowest price and contractors are dependent for their profits on relatively small margins combined with the manipulation of cash flow. For

these reasons, contractors are susceptible to insolvency. Insolvency risks and the mechanisms that have emerged for protecting both clients and suppliers are dealt with at length by Will Hughes, Patricia Hillebrandt and John Murdoch. While the risk of insolvency is higher in the construction industry than in any other, the difference is only very marginal during boom periods, but higher during a recession.

## **HOW PROJECTS ARE ORGANIZED**

Complex tasks require diverse skills. Construction projects, generally, are complex. Even in a fairly simple mediaeval building there were a number of different materials and trades, but in a modern building the number of different skills that are required is vast. Moreover, most buildings are not replicas of others, except for certain types of housing, and they are built over a wide geographical area and each process takes place in a definite sequence. So although it is possible to generalize about the way that construction projects are organized, every project is, in fact, different.

Historically the owner, the financier and the user were the same person. This remains true today for purpose-built dwellings for the well-off, but such projects are rare. From the ownership and rental of land it is a small step to the ownership and rental of buildings. As Ranko Bon points out, compared to other goods, buildings became objects of exchange rather late in human development. According to Christopher Powell, independent developers acting as intermediaries between landowners and people with interests in completed buildings were well established by 1800, in the UK. Thus the financiers of building projects may or may not be the ultimate users. Indeed the

procurement of finance for a construction project has always been a major step in the process.

Financial arrangements aside, a variety of options has evolved for organizing the processes in construction procurement. The separation of responsibility for design from responsibility for building has been a key feature in the evolution of the role of the architect.

In its most simple form building work has always included design. Historically a client would have approached someone to build something, and the builder would have decided how to do it. This simple approach became known as design-and-build and typically dominated the craft-based, pre-industrial construction sector. As the industry evolved along the lines described earlier, the emergence of separate specialist trades led to the need for clients to engage each specialist directly. “Separate trades contracting” was widespread until general contractors appeared in 19<sup>th</sup> century England, for example. Design and construction became separated as the architectural and civil engineering professions institutionalized during the 19<sup>th</sup> century. This led to them focusing on design and restricting their role in the construction process to ensuring that their designs were properly constructed.

A lot of experimentation has taken place among large, continuing clients of the industry. Much of this has revolved around developing long-term business relationships with a limited number of designers, contractors and specialists, and a move away from price as the only means of selection. It remains to be seen how successful this will be as countries everywhere grapple with the difficulty of understanding and organizing construction projects.

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*Will Hughes and Patricia Hillebrandt*

*University of Reading, UK*