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Design management: changing roles of the professions

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This paper sets out to explore how recent changes in procurement in construction have affected the roles that professions play in the design process. It discusses how professions that traditionally took the role of design manager now find themselves participating within previously unforeseen contexts, working in multi-disciplinary teams led by contractors and with changed responsibilities at the design stage. Supply chain members who were not previously involved during the early project phases are being engaged at the earliest phases of the project life cycle and even taking leadership roles while designers sometimes work as supply chain partners.
A study of design in construction and other sectors shows that in dealing with design management issues it is critical to deepen appreciation for the unique characteristics of design and the design process. The paper argues that contractors and designers taking on design management roles in a dynamic industry seeking to explore best practice and innovative approaches to procurement and in the delivery of projects need to acquire new skills, management education and develop the necessary qualities.

1. INTRODUCTION

The design process accounts for a very small proportion of the overall project cost but significantly determines the characteristics and eventual out-turn cost of any project, both in capital and life-cycle terms.[1,2] A large percentage of defects in construction and shortfalls in the construction industry may be traced to actions or decisions at the design stage.[3,4] Furthermore, construction projects are increasingly becoming complex. Market competition and the growing trend of demand for increased efficiency from clients pose a challenge for participants in the construction industry to perform while, at the same time, achieving acceptable levels of profit margin.[5] It is against this background that many practitioners and clients have realised that among the phases that need to be managed well, design is a priority.[6] However, the nature of the design process and the thinking and practice of designers presents a peculiar challenge to managing the design process.[7,8] Due to their training and subsequent experience, designers in all sectors develop mental attitudes and cultures that are often in conflict with that of other project participants; especially managers. In construction, these issues are complicated by the fact that the industry has undergone significant transformation with the evolution of new procurement systems.[9,10]

This paper examines the following two fundamental questions. (*a*) What implications do the changes in procurement have on professional roles in construction? (*b*) What changes in attitudes and skills are required from the professions to adapt to the changing roles?

The first part of the paper reviews the new trends in construction and explores the significance for design management. This is followed by an examination of design theory, the design process and design management from the wider perspective of other sectors.

2. NEW TRENDS IN CONSTRUCTION AND THE CHANGING ROLES OF THE PROFESSIONS

Under the traditional procurement system in construction, architects have customarily taken the role of designers and design manager.[3,8,9] Being the first point of contact for the client they are involved from inception and therefore manage the rest of the design process and the interface between the client, the design team and contractors during construction.[11] As both designer and design manager the architect therefore plays the tripartite role of leader, manager and designer. On projects with a significant element of civil works, both structural and civil engineers have taken the role of design manager in similar situations.[12]

With the evolution of management forms of procurement (i.e. management contracting and construction management), the architect/engineer still performed the role of technical designer and leader of the design process but with a less significant management role. The management role has instead being taken by a managing contractor or, in certain projects in which cost control was paramount to the client, professionals with a quantity surveying background have also taken the role of design manager.

From the 1970s onward, the construction industry in one country after another has undergone a number of changes that have resulted in transformations in procurement systems, contractual relationships and construction methods.[11] In the UK, a turning-point for the roles of professions may be traced to the various reports of the Monopolies and Mergers Commission, which abolished mandatory fee scales and pressed for delivery of professional services in the construction and property industries on a competitive fee-tendered basis.[13–15] Reports such as *Rethinking Construction*,[16] *Modernising*

Construction,[17] *Constructing the Team*[18] and *Accelerating Change*[19] have also played an important role in reshaping the construction industry and resulting in forms of procurement that have affected members of the supply chain. As a result, changes in the roles of those involved in the construction process, including architects and engineers on the one hand and contractors, subcontractors, suppliers and manufacturers on the other, have been forthcoming.

In contractor-led design-and-build and turnkey procurement approaches contractors get involved much earlier in the design phase when the client's requirements are translated into technical drawings and specifications. Under these procurement systems designers are considered part of the contractor's supply chain. The actual technical design is performed by designers who may be part of the contractor's organisation or, as is usually the case, procured by the contractor in some form of service contract. Whatever the case, the contractor takes the design liability and role of design manager and leader. In some cases the contractor may appoint an architect or engineer as the design leader who is ultimately accountable to the contractor.

The Building Down Barriers Initiative, which was a by-product of efforts to reform the construction industry in the UK, led to the prime contracting form of procurement. This initiative addressed the issue of single-point responsibility through prime contractors and supply chain integration. With reference to this initiative Holti *et al*. identified three types of leadership: supply chain leadership, design leadership, and construction/delivery.[20] The emphasis on the role of design leadership was to enable project supply chain members to gain a deeper understanding of the client's strategic goals and to structure dialogue among participants. According to Holti *et al*.,[20] good design leadership would involve improving inter-disciplinary working between different design disciplines on complex projects and achieving efficiency in the design process with a minimum of unnecessary iterations. It would seem that this requirement does not in itself align the design leadership role with any particular profession and therefore it questions conventional practice under traditional procurement in which designers take on design management roles by default.

In the UK, adoption of the private finance initiative (PFI) approach and the variants of public–private partnerships (PPPs) to procurement has led to construction being viewed in the overall context of the strategic goals of clients. It is no longer restricted to realising a physical asset but involves the overall success of delivering a service from financing to operating, maintaining and managing.[21] Inevitably, this has led to the involvement of a spectrum of stakeholders including engineers, architects, cost consultants, contractors, lawyers, insurers, financiers, bankers, suppliers, etc. over relatively long periods, often working within the same team and at different periods. Due to the implications of decisions made at the design stage, all these stakeholders are eager to be involved from project inception and throughout the various stages of design.[22–24] The special project vehicle (SPV) acting as a surrogate client brings the supply chain together to deliver infrastructure needed to fulfil the objectives of the project. Depending on the contractual set-up, the design and construction phase may be delivered under a design-and-build, traditional or one of the management forms of procurement strategy but the designers are usually treated as part of the supply chain.[25] They are responsible for the technical design of the physical infrastructure assets but the role of managing and leading the design process is determined by the SPV, depending on the requirements of the stakeholders.

The developments discussed above have influenced the design process and substantially changed roles of professions and composition of design teams (part (a) in Fig. 3 highlights the key issues in the above discussion). These trends obviously present organisational and work practice challenges and have an impact on traditional attitudes and culture of project teams. Fig. 1 schematically presents the major procurement systems against the project value chain. The thick black lines in the figure denote major value transition points and the dotted lines draw attention to the design phase from which the changing roles with procurement routes is evident. In general, procurement systems at the top of the diagram provide more opportunity to maintain the integrity of the project value chain since an increased number of discrete activities come under one umbrella organisation for single-point delivery. There is one proviso: they must be designed and delivered with that intent in mind.

In summary, the trends in the construction industry underscore the fact that change is inevitable. Initiatives aimed at reforming construction have affected design management roles and new procurement routes such as prime contracting, early contractor involvement, design and build and PFI/PPP have experimented with contractors in design leadership roles. It is the contention of the authors that a deeper understanding of design theory from a wider perspective highlights unique characteristics of designers and the design process that have implications for skills and attitudes needed for design management in construction.

3. UNDERSTANDING DESIGN, THE DESIGN PROCESS AND DESIGN MANAGEMENT

In a multi-sector context, the term design is used by people in different contexts and means different things to different people.[26,27] Whereas the previous section uses the term design from a construction point of view, including the process of translating the client's requirements into technical solutions and expressing these solutions in the form of drawings and specifications, this section takes a broader view. The authors believe that ongoing efforts to reform the construction industry and to change attitudes and acquire relevant skills can be strengthened by taking best practice lessons from other sectors in line with critical recommendations in *Rethinking Construction*,[16] *Modernising Construction*[17] and more recently *Improving Public Services through Better Construction*.[28]

Cooper and Press have explored different perspectives or definitions of design across sectors to reveal its broad nature and various functions in industry and society.[7] According to their research, design can, among other things, be viewed as an art, a creative act, as problem solving, as a family of professions or as a process.

The concept of design as an art is seen in the patterns of products demanded by consumers. From basic household items to automobiles and infrastructure, consumers now want products

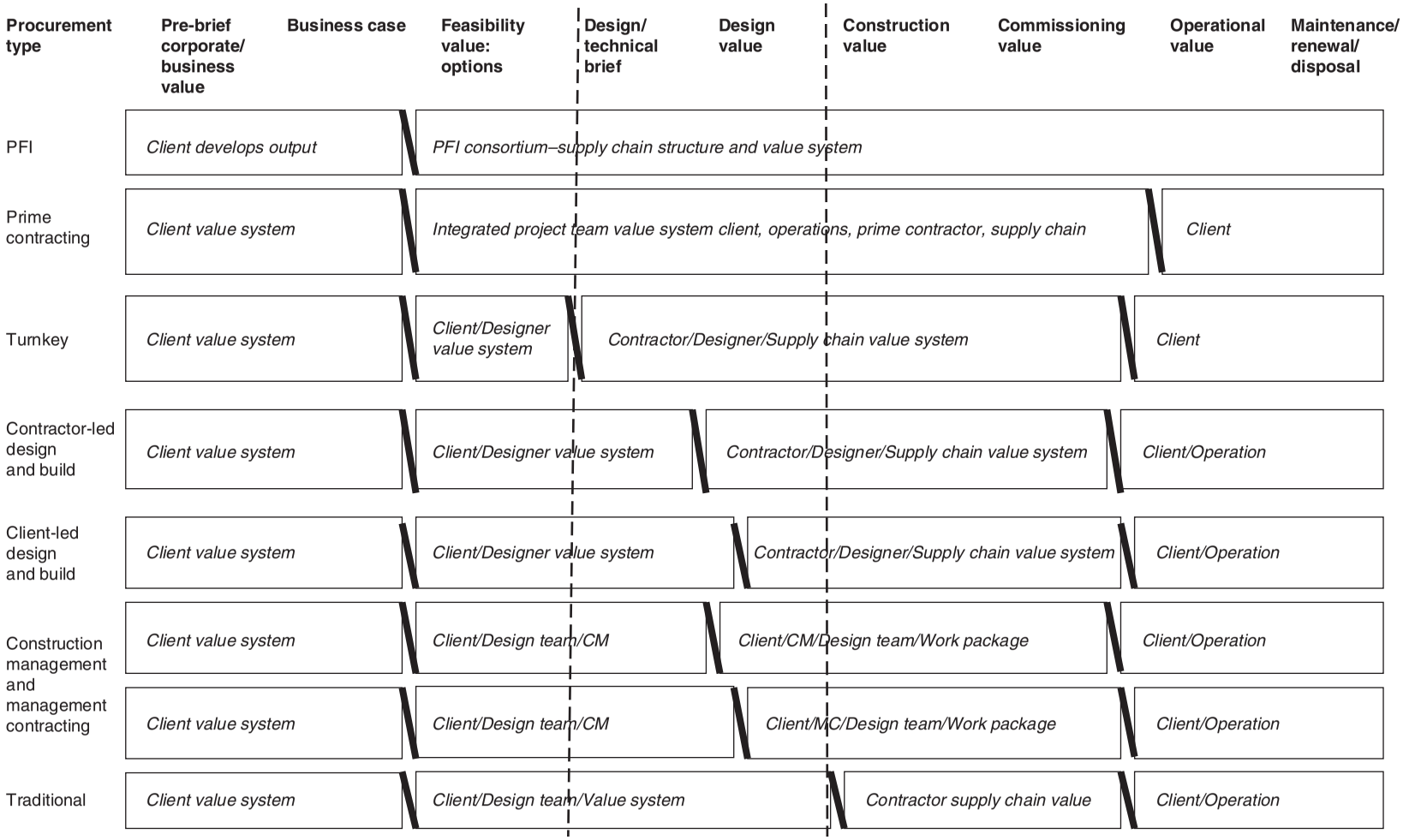

Fig. 1. Procurement strategies and the project value chain[10]

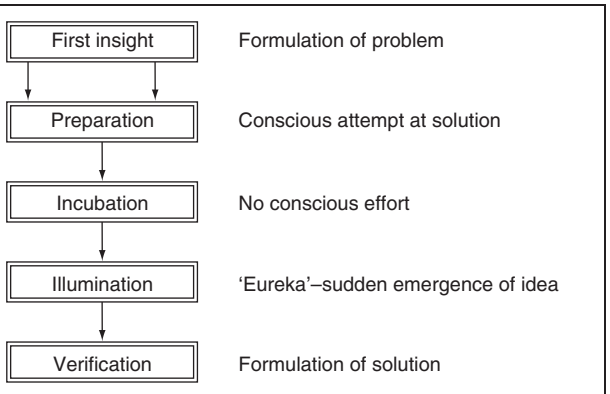

Fig. 2. The popular five-stage 'Eureka' model of the creative process. Adapted from Lawson[26]

that do not just serve the basic purpose but also reflect a sense of style, popular ideals and aspirations. The concerns of design to express lifestyle have always been paramount in the fashion industry.[6] The same principle is being extended into other sectors.[29] Furthermore, consumers look to design not just to manifest function but also to reflect values.

The works of famous people such as Leonardo da Vinci, Mozart, Le Corbusier, Brunel and Stephenson have led many to view the concept of design as a creative act with an almost mystic aura surrounding it. Along with such popular views is the notion that creativity is restricted to certain fields of endeavour.[30] One model classifies design into five phases to encapsulate the creative process (Fig. 2).

This 'eureka' model which is synonymous with Archimedes gives the impression that design is a matter of brilliance. Scientific evidence, however, suggests that creativity comprises the application of a set of skills that can be learned and developed and can be seen at work in all activities.[7]

The concept of design as a problem-solving activity is by far the most widely known and easily acceptable perspective of what design is. People will generally accede that design is about conceiving things which meet specific needs.[31] These needs may be purely functional or decorative. As the products of design fulfil a specified function then, design is an activity concerned, at least in part, with solving problems. Any design problem will include balancing a range of requirements against constraints determined by technology and materials, production, market considerations and human factors—the physical and psychological characteristics of users. The designer has the task of balancing these factors to create products, messages and environments that are functional, flexible, affordable, well made and elegant.[6]

The brief description builds an appreciation for the diversity of design. However, designers are traditionally identified not so much by the problems they tackle but rather by the kinds of solutions they produce. This often gives each 'trade' of designers a unique line of thought and values. As a result of the close interlinks between these designers, the design solution of one designer is often the problem that another designer starts with. In construction of high-rise buildings, the relationship between architect and structural engineering designer is a typical example.

Design solutions do not naturally have an end and there is no way of deciding beyond doubt when a design problem is solved.[26] Designers simply stop designing either when they run out of time or when, in their judgement, it is not worth pursuing the matter further. This obviously has implications for how much time should be allowed for the solution to evolve.[27,32] What is more, the magnitude of the design problem often becomes clearer as progress is made towards some sort of solution. Thus substantial effort may be required before the designer is really aware just how difficult a problem is.

Belev noted that, unlike other trades, design problems must be discovered, and very often neither the goal nor the obstacles to achieving that goal are clearly expressed. The effect of this is that designers tend never to be satisfied with the problem presented.[31] Design problems are also often multidimensional and highly interactive in the sense that the design is often expected to serve more than one function even when not stated explicitly. In addition, as with any problem, there are many limitations amidst which the designer is expected to devise an integrated solution to a whole cluster of requirements.[7]

Underlying the above discussion is the fact that in design, problems do not usually originate in the designer's mind but with the client.[6] The client's problem may be presented by someone who is fairly knowledgeable regarding design, but in many cases the client vaguely understands the problem and in construction terms may not understand how the industry works. Furthermore the 'client' is hardly an individual but rather a whole group of people tasked with representing the 'client'. A great deal of design work may also be commissioned by a client who is different from the final end user.[8] This raises both organisational and communication bottlenecks and makes the management of design different from other areas that need to be managed.

In most industries much apprehension exists regarding management of design.[33] Managing the formative stages of design does not easily lend itself to being managed with the same mechanistic focus that can be applied to other phases. As previously discussed, the early phases of the design process require a period of synthesis that can not always be 'forced' and the mind needs time to work on the problem. The amount of time needed may be great or small and this may appear to make the management of time, and in consequence the cost of the design work, an improbable task.

Another reason for the apprehension in managing design has to do with the clash of cultures between managers and designers that often stems from divergent personal aptitudes and educational backgrounds.[26,34] For most managers who come to terms with it, design is a resource that can add value to products and services. In contrast, designers may have other priorities such as environmental issues; a desire to elevate public taste and influence culture; or even to help bring about social and political change. While good managers may sympathise with these aims, their main interest in design is invariably 'design for profit'.[27] This obviously presents management difficulties. In construction, this clash of cultures

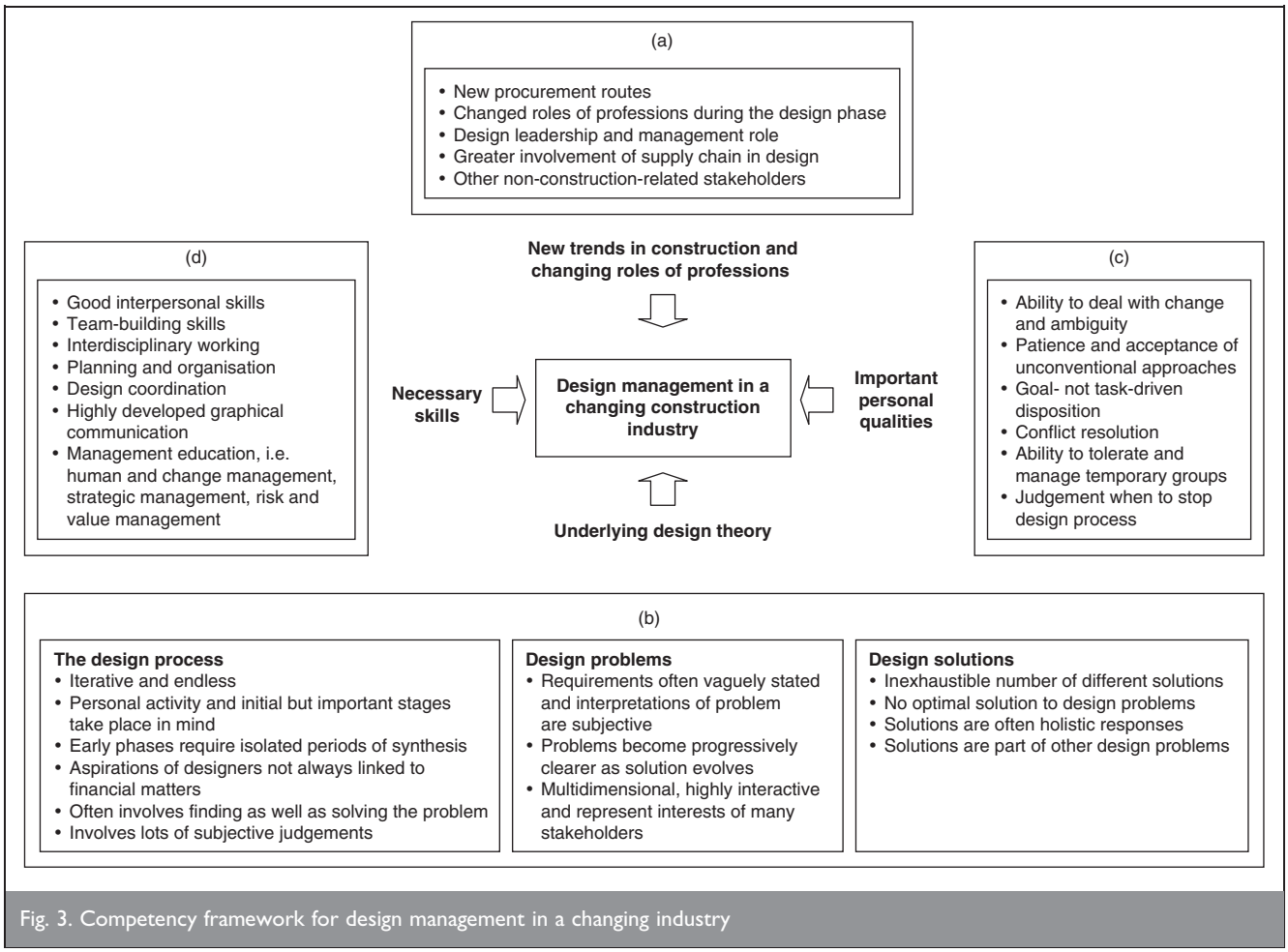

Fig. 3. Competency framework for design management in a changing industry

may lead to strained relationships between designers and contractors in an industry that is changing its approach to procurement and delivery of projects. The different styles of thought also make the chasm wider.[35] Managers learn to like things to be precise whereas designers may like to experiment with unconventional procedures. Most contractors will be familiar with management approaches that incorporate the use of concepts such as work breakdown structures, critical path analysis and earned value methods that are perfectly applicable and useful for management of construction projects. In contrast, many designers are not comfortable with these approaches and their underlying philosophies.[36]

As a precursor to the skills needed to manage design in an industry that is experiencing reforms in procurement, this section has explored the design theory and the nature of the design process. Construction design seems to be conceived as a problem-solving activity, but because the problem does not originate with the designer, designers must go through a cyclic and iterative process to come up with solutions that are acceptable. The nature of the design process also implies that in the context of the changing design management roles, educational backgrounds and aptitudes influenced by experience in different stages of the construction process lead to difficulties.

Part (b) in Fig. 3 isolates the main design theory and design thinking issues in this section. The final part of this paper discusses the skills and qualities needed to manage designers and the design process.

4. ADAPTING TO CHANGES

Oakley distinguishes the role of design manager from that expected of the traditional manager in terms of their qualities.[34] The main quality of an effective design manager is the ability to deal with change and ambiguity. This is a unique requirement because the design process is iterative and, as previously stated, the formative stages take place in the mind, without tangible outputs. The initial stages of design in architectural, engineering or construction (AEC) projects are creative and very personal.[26,33] Designers usually spend time defining and realising their objectives and respective priorities and only when the design is complete can the results of their intense intellectual activity be seen. As explained earlier, this is at the heart of the problem of design management.

In the design of AEC products the client's requirements are often vaguely stated due to the differing interests. The designer proposes various possible solutions, taking into account the influence of external factors such as statutory, planning, environmental and construction needs before an acceptable solution is reached.[37,38] Since design of AEC projects is a process of human interaction, the outcome contains the interpretations and perceptions of the people involved. The acceptability of the outcome is also based on a trade-off among individuals about what they are willing to accept as a satisfactory interpretation of their ideals.[3,4] Inevitably, design is a trade-off between conflicting needs until there is a solution that enables everyone to move forward.[8,39] This is often referred to as 'satisficing'.

The 'eureka' model described earlier aptly describes the design process; nevertheless it must be acknowledged that design in AEC projects is not necessarily a linear sequence. Gray and Hughes propose that unlike design in the manufacturing industries, designers in AEC projects actually think freely across and around the boundaries of a problem; and a cyclic/iterative model is more realistic and representative of the design process for AEC design.[8] The reflective model suggested by Schön, which bears similarities with this iterative model, reinforces this paradigm.[40] An iterative/reflective model may explain the difficulties in reconciling the expectations of people from contractor or management backgrounds when managing designers and the design process.

In terms of the changes in procurement that the construction industry has experienced, the changing role of professions has implications for the skills required for successful design management.

Being the first point of contact by the client under traditional procurement, the architect or engineer acts as technical designer. As in most cases, the architect or engineer is also the client's agent, they manage the interface with other designers, in effect leading the design team and managing the design process. The sequential nature of the design and construction process in traditional procurement also means that there is little interaction between the designers and contractors at the early stages of the project life cycle and contractors only get involved when the creative, artistic and problem-solving stages of design are substantially complete.

The earlier involvement of contractors in the management forms of procurement has meant that while designers still take on the traditional technical design roles and perhaps quantity surveyors may take on the cost control roles, managing contractors have an influence on the design and need client-oriented skills when they may act as design managers in these procurement routes. This often presents a challenge as the contractor places more focus on the project scheduling and buildability.

In client-led design-and-build procurement projects the architect or engineer may lead the design process up to the schematic design stage. The design role then becomes part of the design-and-build contractor's role, which is more akin to turnkey procurement. In contractor-led design and build the design manager fulfils a role between the client-led design-and-build and turnkey procurement. Therefore a balance of design team management and client-handling skills is needed. In turnkey projects the designers are usually taken on as part of the contractor's supply chain. This means the contractor may lead and manage the team of designers as they develop technical solutions to fulfil the project objectives. In this case the design manager will need good team management and supply chain management skills in addition to the clienting skills.

In prime contracting, the integrated team nature of the procurement process means that designers, contractors, subcontractors, facilities managers, manufacturers and other supply chain members usually involved at the later stages of the project life cycle are engaged quite early in the design process. The emphasis is therefore on team and supply chain management skills. As the contractor manages the interface between the client and others, the design manager needs good interpersonal skills and should be capable of interdisciplinary working. Designers often express their thoughts through sketches and drawings and may not necessarily consider the cost implications until the design is considerably complete whereas contractors will be interested in the cost and constructability implications. The design manager will therefore need to have highly developed graphical communication and design coordination skills in addition to a keen eye for cost implications of design decisions.

The other design management qualities that are similar to those required of a project manager include: conflict resolution skills, acceptance of diversity of approach, goal rather than task-driven disposition, combination of action with reflection instead of physical activity, encouraging a team approach rather than individual approach to problem solving, knowledge based on structural updating and not necessarily experience, and toleration of temporary groupings and the ability to manage them well contrasted with stable relationships in traditional management.[27,34,35,41,42]

To be effective as a design manager in a rapidly changing construction industry, the skills and qualities discussed may be beneficially strengthened by acquiring the relevant management education, which may include human behaviour and change management, strategic management, risk and value management.

Organisations must adjust their form and culture in response to the tides in the external environment. Cole[43] identifies two types of change: reactive change which results as a response to external or internal influences and planned change which is initiated by the organisation proactively. It would be in the interest of the various professions whose roles are changing to explicitly plan the change of culture, mindset and disposition in order to influence the changing trends. Reactive change limits opportunities to influence trends and roles.

In summary this paper has reviewed the new trends in construction and highlighted the implications of the changes in procurement to the role of design manager. Fig. 3 summarises the key themes and arguments in this paper.

5. CONCLUSIONS

Comparison of the changing requirements for design management under the different procurement routes linked with the general disposition of designers raises questions about the suitability of current training of most 'designers' to ably lead the design process in line with expectations of industry reform and new procurement systems. On the other hand experiences from recent projects in which contractors have taken on design leadership roles under the new procurement routes show that to successfully manage designers and the design process, an insight into design theory is a critical element. Whether from a contracting or design background it is imperative that design managers in the construction industry develop qualities both to manage multi-disciplinary teams and to effectively tap the potential of designers, linked with essential front-end clienting skills.

Designers must acknowledge that the more traditional ways of procuring and delivering projects may not be preferred by many clients, especially in view of the increased complexity of today's projects. They have to look to their real areas of strength and develop them and also explore the areas of their deficiencies and work on improving them. Under the new procurement routes, it is design that will enhance and distinguish their role in the project team because design is an activity that is different from operations. The concern should not only be with creativity and innovation but also with delivering practical solutions that take into consideration better quality of construction, sustainability and whole-life costing. It would be misleading to assert that a certain profession produces the best design managers because there are both strengths and weaknesses with the mindset and culture of all professions. However, it seems reasonable to conclude that individuals can learn design management skills. The issues discussed in this paper may well challenge the manner in which design professions develop in the future and has clear implications for the manner in which designers and other members of supply chain teams are educated and/or trained.

REFERENCES

1. Institute of Asset Management. *International Infrastructure Management Manual*. Institute of Asset Management, London, 2002.
2. Kelly J., Morledge R. and Wilkinson S. *RICS Foundation. Best Value in Construction*. Blackwell Science, Oxford, 2002.
3. Coles E. *Design Management: A Study of Practice in the Building Industry*. The Chartered Institute of Building, Englemere, Berkshire, UK, 1990, occasional paper No. 40.
4. Cornick T. C. and Mather J. *Construction Project Teams: Making them Work Profitably*. Thomas Telford, London, 1999.
5. Smith N. J. *Appraisal, Risk and Uncertainty*. Thomas Telford, London, 2003.
6. Borja de Mozota B. *Design Management: Using Design to Build Brand Value and Corporate Innovation*. Allworth Press, New York, 2003.
7. Cooper R. and Press M. *The Design Agenda: a Guide to Successful Design Management*. Wiley, Chichester, 1995.
8. Gray C. and Hughes W. *Building Design Management*. Butterworth-Heinemann, London, 2001.
9. Fewings P. *Construction Project Management: an Integrated Approach*. Taylor & Francis, London, 2005.
10. Bower D. *Management of Procurement*. Thomas Telford, London, 2003.
11. Alarayedh A. D. *The Changing Role of Architects and Contractors*. MSc thesis, University of Leeds, 2005.
12. Masterman J. W. E. *An Introduction to Building Procurement Systems*, 2nd edn. Spon, London, 2002.
13. Monopolies and Mergers Commission. *Architects' Services: A Report on the Supply of Architects' Services with Reference to Scale Fees*. HMSO, London, 1978.
14. Monopolies and Mergers Commission. *Surveyors' Services: A Report on the Supply of Surveyors' Services with Reference to Scale Fees*. HMSO, London, 1977.
15. Monopolies Commission. *Report on the General Effect on the Public Interest of Certain Restrictive Practices so Far as they Prevail in Relation to the Supply of Professional Services*. HMSO, London, 1970.
16. Egan J. *Rethinking Construction*. Department of Trade and Industry, London, 1998.
17. National Audit Office. *Modernising Construction*. National Audit Office, London, 2001.
18. Latham M. *Constructing the Team: Final Report of the Government/Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry*. HMSO, London, 1994.
19. Strategic Forum for Construction. *Accelerating Change*. Strategic Forum for Construction, London, 2002.
20. Holti R., Nicolini D. and Smalley M. *The Handbook of Supply Chain Management—The Essentials*. CIRIA, London, 2000.
21. Merna A. and Njiru C. *Financing Infrastructure Projects*. Thomas Telford, London, 2002.
22. Merna A. and Smith N. J. *Guide to the Preparation and Evaluation of Build Own Operate Transfer Project Tenders*, 2nd edn. Asia Law & Practice, Hong Kong, 1996.
23. Merna T. and Al-Thani F. *Corporate Risk Management: An Organisational Perspective*. Wiley, Chichester, 2005.
24. Smith N. J., Merna T. and Jobling P. *Managing Risk in Construction Projects*. 2nd edn. Blackwell Publishing, Malden, MA, 2006.
25. Aritua B. *Design Management in the New Collaborative Procurement Systems*. MSc thesis, University of Leeds, 2005.
26. Lawson B. *How Designers Think: the Design Process Demystified*. Architectural Press, Oxford, 1997.
27. Reinersten D. G. *Managing the Design Factory: A Product Developer's Toolkit*. Free Press, New York, 1997.
28. Latham M. *Improving Public Services through Better Construction*. National Audit Office, London, 2005.
29. Koskela L. Application of the new production philosophy to construction. *Proceedings of the International Group for Lean Construction (IGLC)*. Lean Construction Institute and Centre for Integrated Facility Engineering (CIFE), Stanford, CA, USA, 1992, technical report no. 72, 81pp.
30. Colt W. J. Use a quality management plan for engineering design. *International Water Power and Dam Construction*, 1995, **47**, No. 1, 22–35.
31. Belev G. C. Design management—begin at the beginning. *Proceedings of the 1992 Annual Reliability and Maintainability Symposium, Las Vegas, NV*. IEEE, Piscataway, NJ, 1992, 98–100.
32. Emmitt S., Sander D. and Christofferson A. K. Implementing value through lean design management. *Proceedings of the 12th International Group for Lean Construction (IGLC) Conference, Copenhagen, Denmark*, 2004.
33. Koskela L. and Ballard G. On the agenda of design management research. *Proceedings of the International Group for Lean Construction (IGLC)*. Lean Construction Institute, Oakland, CA, USA, 1998.
34. Oakley M. *Design Management: a Handbook of Issues and Methods*. Blackwell Publishing (Reference), Oxford, 1990.
35. Terje V. Improving project collaboration: start with the conflicts. *International Journal of Project Management*, 2004, **22**, No. 6, 447–454.
36. Kerzner H. *Project Management: a Systems Approach to Planning, Scheduling, and Controlling*, 8th edn. Wiley, New York, 2003.
37. Beach R., Webster M. and Campbell K. M. An evaluation of partnership development in the construction industry. *International Journal of Project Management*, 2005, **23**, No. 8, 611–621.

38. GERARD R. Relational contracts–NEC in perspective. *Lean Construction Journal*, 2005, 2, No. 1, 80–86.
39. BALLARD G. Construction: one type of project production system. *Proceedings of the 13th International Group for Lean Construction (IGLC) Conference, Sydney*, 2005.
40. SCHÖN D. A. *The Reflective Practitioner: How Professionals Think in Action*. Arena, Aldershot, 1995.
41. SHINGO S. *Study of 'TOYOTA' Production System*. Japan Management Association, Tokyo, 1984.
42. MOUSSA N. *The Application of Lean Manufacturing Concepts to Construction: A Case Study of Airports as Large, Regular Procuring, Private Clients*. PhD thesis, University of Leeds, 1999.
43. COLE G. A. *Organisational Behaviour: Theory and Practice*. DP Publications, London, 1995.

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