

Process Management in Design and Construction

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Preface

In 1995, Peter Brandon, Professor of Construction at the University of Salford, called me and asked if I was interested in considering construction as a manufacturing process. Quite frankly, I had never heard of it, but the idea was enticing. Having spent many years in research-related design and developments in manufacturing, I was curious to know if knowledge was transferable. This was the beginning of a fascinating journey into the world of construction. Working with colleagues in academia and industry, it soon became obvious that 'process' thinking as we understood it in manufacturing was not common in design and construction. This book is the result of research (funded by the Engineering and Physical Sciences Research Council) investigating and developing new design and development processes for the 'construction product'. The project was led initially by Alfred McAlpine Special Projects and especially by the then Board Director, Dr Richard Baldwin. This was a crucial aspect of the success of the work, since Dr Baldwin had extensive experience in manufacturing and construction, he too could understand the value of improving the design and construction process. Along with Alfred McAlpine, we were also able to engage other partners from across the sector to work with us to understand current issues and to develop a future process. Those partners included further champions, such as Mathew Bacon who was also one of the front guard introducing 'process' management for construction with BAA, and Keith Hamblett doing the same for BT.

As the work developed, many more contributors came from industry – too many to mention, but undoubtedly, without their support, enthusiasm and importantly, their intellectual and practical contributions, the work would not have produced as an appropriate, and therefore targeted, outcome as it did.

Halfway through the development, Professor Tony Thorpe and a team from Loughborough University joined our endeavours and to develop more detail to the original process protocol.

In the eight years since we began our work, 'Process' has been identified by the construction industry as an important issue to address. It is recognised that in order to deliver a 'construction product' on time, on cost and of the highest quality, it is critical to manage the process (and the problems) effectively.

This book provides the context for 'process' thinking. It describes the Process Protocol and the experience of implementing it in practice.

Rachel Cooper

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After gaining an MSc in IT in Property and Construction, Andrew joined the Process Protocol team. He is currently engaged as a Research Fellow on an EPSRC project entitled 'Managing Change and Dependency in Construction'. His research interests are construction process improvement and management, change management, facilities management and development management.

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Dr Kagioglou is a Senior Research Fellow and the Manager of the EPSRC-funded Salford Centre for Research and Innovation (SCRI) in the built and human environment. He comes from a manufacturing background, he has published widely and his current research looks at process management and enabling mass customisation capabilities for construction supply chains.

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The work upon which the Process Protocol project is based took place over a period of six years, between 1995 and 2001, and is continuing in other guises today. The research team was supported with enthusiasm by a group of individuals and companies, without whom the work could not have been done. The group includes John Hinks, Richard Baldwin, Mathew Bacon, George Stevenson, Bob Waterman, Keith Hampson, Paul Jarvis, Nigel Curry, Andrew Waugh, and Trevor Morgan. The companies who partnered us contributed their time and expertise and these include Alfred McAlpine, AMEC, BAA, BIW Technologies, BRE, BT, Capita Property Consultancy, Hammonds Suddards Edge, IAI Client Briefing Domain, IAI Facilities Management and the Waterman Partnership. However, there were many more individuals and organisations that attended the 30 workshops and seminars, and provided insights into a process for the future. The research team were further supported by Daryl Sheath who undertook early work, Stuart Carmichael for his work on Britannia Walk (supported by Tony McCarthy and funded by the DTI) and Jeremy Grammer whose early work on Marconi Lifecycle Management informed ours. From 1999, the research team on the project included colleagues from Loughborough University, including Simon Austin, Andrew Baldwin, Chris Carter, Adam Green, and, most particularly, Tony Thorpe. None of this work would have been achieved without such collaboration or without the funding of the Engineering and Physical Sciences Research Council (EPSRC). Finally, a special thank you to Ginny Spencer for her help in putting the book together and to Andrew Wootton, who designed the first process map upon which all the future iterations were based.

Introduction – Why Process?

The UK construction industry has been under increasing pressure to improve its practices (Hill, 1992; Howell, 1999). It has been continuously criticised for its less than optimal performance by several government and institutional reports such as Phillips (1950), Emmerson (1962), Banwell (1964), Gyles (1992), Latham (1994) and, more recently, Egan (1998). Most of these reports conclude that the fragmented nature of the industry, the lack of co-ordination and communication between parties, the informal and unstructured learning process, adversarial contractual relationships and the lack of customer focus are what inhibit the industry's performance. In addition, construction projects are often seen as unpredictable in terms of delivery time, cost, profitability and quality, and investment into research and development is usually seen as expensive when compared to other industries (Egan, 1998; Fairclough, 2002).

According to Howell (1999), the 'inefficiency' of the industry has tended to be the way of life. This may be due to the fact that none of the reports, apart from Latham (1994) and Egan (1998), have been sufficiently acted upon. As Latham (1994) points out, '...some of the recommendations of those reports were implemented... but other problems persisted, and to this day, even the structure of the industry and nature of many of its clients has not changed dramatically'. Therefore, Latham (1994) suggests using manufacturing as a reference point and Egan (1998), in his *Rethinking Construction* report, recommends process modelling as a method of improvement.

The transfer of practices and theories from other sectors, as suggested by Latham (1994), has been a constant subject of discussion since the publication of his report. Some construction practitioners are adamant that their industry is unique and that the transference of principles cannot be adopted wholeheartedly. Ball (1988) highlights some of the arguments most commonly used to distinguish construction from other industries:

- The one-of-a-kind product.
- The spatial fixity of buildings.
- On-site production.
- The effect of land price on design and construction possibilities.
- The requirement for long life expectancy.
- The inexperience of clients.
- The merchant/producer role of companies.
- The overwhelmingly domestic industry.
- The masculine stereotype of the workforce.

- The long cycle from design to production.
- The high cost of the projects.
- The amplified reaction to economic crises.
- The labour-intensive production.
- The fragmented nature of the industry.

In contrast, there are also many practitioners and academics who believe that the construction industry has much to learn from manufacturing. Howell (1999) goes so far as to suggest that this learning could be a two-way process: manufacturing could learn from construction in areas such as project-based management: and construction could learn, from manufacturing's developed and developing solutions, to improve its competitiveness.

According to Koskela (1992), Love & Gunasekaran (1996) and Kornelius & Wamelink (1998), manufacturing has been a constant reference point and a source of innovation in construction for many decades. Solutions that have been recommended to help overcome the problems of construction include industrialisation (i.e. prefabrication and modularisation), computer-integrated construction, robotics and automated construction (Koskela, 1992; Love & Gunasekaran, 1996; Kagioglou *et al.*, 1998a). However, their implementation in manufacturing is far advanced in comparison to the construction industry. Koskela (1992) believes that the underlying theories and principles of manufacturing should be harnessed to deliver the full benefits to construction rather than the 'technological solutions'.

The realisation that the construction industry might not be as unique as was traditionally thought has initiated new research in recent years. In particular, this has led to the development of the 'Construction as a Manufacturing Process' research fund under the Innovative Manufacturing Initiative (IMI) sector of the Engineering and Physical Sciences Research Council (EPSRC, 1998) to continue and expound upon current thinking. (This book is based on research funded under that initiative.)

It now appears that a new phenomenon is being steadily exploited within construction companies alongside the new technologies taken from manufacturing. It is based upon the development and use of fundamental core processes to improve the efficiency of the industry, with great emphasis upon the basic theories and principles underlying the design and construction process. Egan (1998) highlighted this factor by reporting that due to the fragmented nature of the construction industry very little work had gone into process modelling. Manufacturers are accustomed to taking a process view of their operations; they usually model both discrete product activities and holistic high-level processes for both internal and external activities. In particular, there has been a growing volume of research focusing upon the consolidation of the just-in-time (JIT) and the total

quality management (TQM) philosophies, with an array of other practices such as total productive maintenance, visual management and re-engineering (dos Santos *et al.*, 1999). Investigations by construction practitioners and academics alike have now sought to develop the content and structure of the core ideas underlying these theories, namely world-class manufacturing, agile production and lean production (Schonberger, 1996; Gilgeous & Gilgeous, 1999). This has led to a range of corresponding practices, for instance, world-class construction, agile construction and lean construction, as it is believed that process improvement in the construction industry may well be a significant strategy for getting the right product to the right market at the right time, cost and quality (Pheng & Tan, 1998).

As the construction product has in most instances been a 'one-off', much emphasis has been placed on project management. Yet in effect the industry is concerned with the design and development of a building product and should look to manufacturing for reference on how to manage the design and development process. This book will examine the manufacturing perspective and will illustrate how it can be applied to design and construction through the use of a case study in the development of a Generic Design and Construction Process Protocol. It will also consider the use of the techniques and technologies available to support the process and the issues relating to their implementation on projects.

1

The Product Development Process

'Product development is fundamental to stimulating and supporting economic growth for organisations and for wealth generation in many industrialised nations . . . product development is a strategic process, and product development and design activities are powerful corporate tools.'

Bruce & Biemans, 1995.

In order to overcome the barriers within construction as identified in the Introduction, it was suggested that construction should be viewed as a product development process. It is therefore important to understand current thinking on new product development (NPD). This chapter uses the product development process in manufacturing as a reference point for defining and understanding the design and construction process (see Fig. 1.1). The importance of new product development is discussed together with the activities and models used to illustrate it. Having considered briefly the history of construction, its project-based orientation and the existing models of the design and construction project process, the chapter will conclude with an explanation as to why a holistic product development view of construction is necessary.

Product development in manufacturing

If the world were stable there would be no need to change business operations and methods or to understand what has changed and what works well. However, firms operate in dynamic environments, not stable ones, and both external competition and internal environments evolve over time.

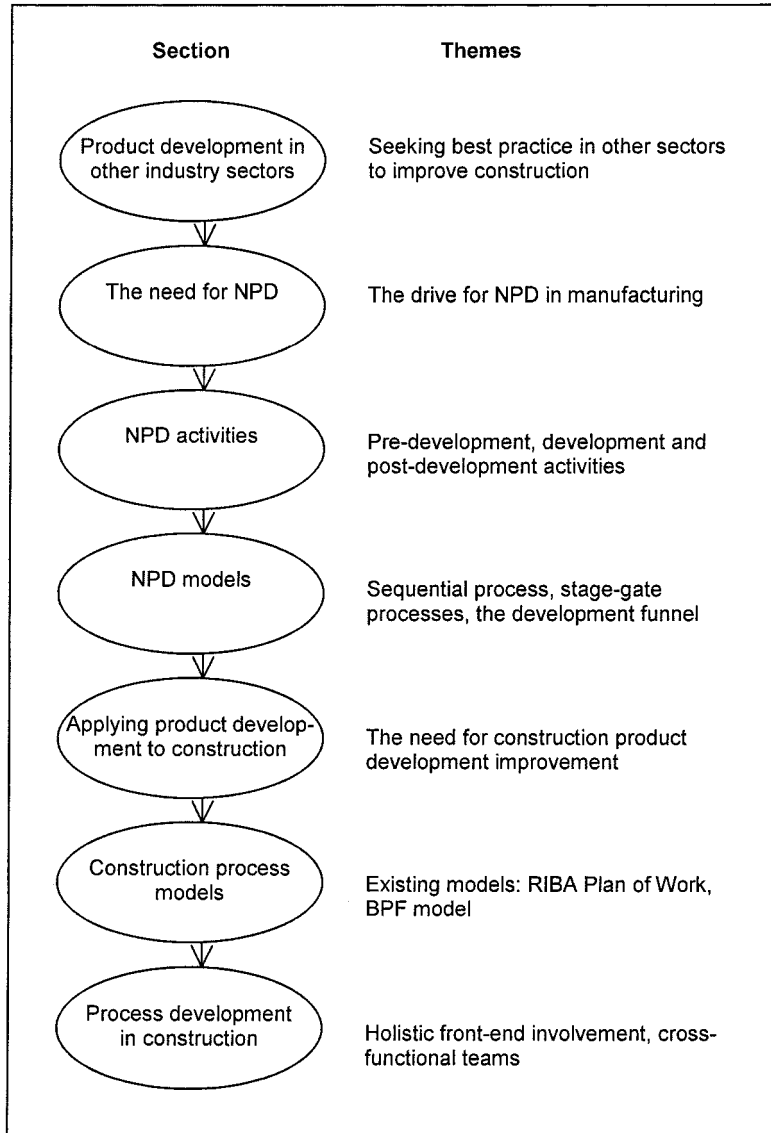


Fig. 1.1 Chapter map.

In response, processes must also continuously adapt to enable those firms to remain effective and profitable through the changing conditions (Moran & Brightman, 1998). Therefore organisations wishing to undertake improvements in productivity, quality and operations need to reconsider their working practices (Elzinga *et al.*, 1995). Katzenbach (1996) reports that organisational change is becoming everyone's problem and that customers require it, shareholder performance demands it and continued growth

depends upon it. Customer/client awareness and expectations have increased in terms of quality and value for money. The manufacturing industry has been developing new approaches to NPD since the 1970s by modelling and improving its processes. Egan (1998) supports this drive and suggests that the construction industry could also improve its performance by modelling its processes.

The need for new product development (NPD)

In a dynamic economy, developing and introducing new products is essential for a company's survival (Schmidt, 1995) and the successful management of new products has become both a necessity and a way of life (Sarin & Kapur, 1990). A number of studies have indicated that companies rely on new products to generate profits (Baker, 1983) and will continue to do so, to a greater extent, in the future (Thomas, 1993). Ames & Hlavacek (1984) indicate an increase in profits contribution from new products: from nearly 23% in the period 1978–81, it increased to 32% in the period 1981–86. Booz, Allen & Hamilton (consultancy practice) surveyed 700 companies in 1982 and reported that 31% of the companies' profits would come from new products over the next five years. Moreover, in the USA in the year 2000, 50% of company profits came from new products that were five years old or less (O'Connor, 1986).

New product development (NPD) is a necessary risk that companies must undertake. Technological developments, shorter product life cycles, the complexity of products, increasingly changeable market demands, customers who demand 'the best', and stronger and more global competition mean that companies face a limited space in which to succeed (Ross, 1994; Trygg, 1993; Oh & Park, 1993; Inwood & Hammond, 1993; Gupta & Wilemon, 1990).

NPD is a critical means by which the whole organisation – the business as well as the employers – can adapt, diversify and, in some cases, reinvent the firm to match evolving market and technical conditions (Schoonhoven *et al.*, 1990). Brown & Eisenhardt (1995) suggest that, although technical and market changes can never be fully controlled, proactive product development can influence the competitive success and renewal of organisations.

Since the 1970s, and particularly since the mid-1980s, the literature on new product development has grown very large. Many studies have been undertaken to determine critical success factors in NPD (Cooper, 1992; Clark & Fujimoto, 1991; Zirger & Maidique, 1990; Cooper & Kleinschmidt, 1987b; Rothwell *et al.*, 1974; Rothwell, 1972). Rothwell (1972) identified a number of success factors related to the individual activities involved in the NPD process, and concluded that the way in which those activities are

performed needs to change in order to increase competitiveness, success and survival rate. The sequence and relevance of those activities, among themselves and in relation to the rest of the organisation's activities, form the NPD model. Cooper (1994) defines the model, or new product process, as '... a formal blueprint, roadmap, template or thought process for driving a new product project from the idea stage through to market launch and beyond'.

NPD activities

It is widely accepted that in order to move a new product idea through to production and on to final launch in the marketplace a number of activities must be performed (Utterback, 1971). Initiated by the identification of a need or the adoption of an idea, a number of preliminary evaluations are carried out. Further detailed technical development follows and finally, after a series of company and market tests, the finished product is launched onto the market (Crawford, 1994). The way in which these activities are performed has been, and still is, a subject of research and has resulted in a number of new product development process models.

The number of stages involved in an NPD process ranges from six (Booz, Allen & Hamilton, 1982) to as many as 13 (Cooper & Kleinschmidt, 1986) and many firms frequently omit, either intentionally or accidentally, some of these activities when developing new products (Dwyer & Mellor, 1991; Sanchez & Elola, 1991). Generically, the NPD activities can be separated into three broad main categories: the pre-development activities, the development activities and, finally, the post-development activities (Cooper & Kleinschmidt, 1988).

Pre-development activities

The sources and ultimate users of the information needed for the pre-development activities are provided from within the company (research and development, marketing, manufacturing, sales and management) or from outside (customer needs and requirements) (Rochford & Rudelius, 1992). In a logical order, the first activity of the NPD process is idea generation or establishing the need, followed by a number of preliminary market, technical, financial and production assessments (Marquis, 1972). Baker *et al.* (1983) defines the idea or need as '... a potential proposal for undertaking new technical work which will require commitment of significant organisational resources', and idea generation as the '...coming together of an organisational need, problem or opportunity with a means of satisfying the need, solving the problem, or capitalising on the opportunity'.