Handbook of Research on Knowledge-Intensive Organizations

Dariusz Jemielniak
Kozminski University, Poland

Jerzy Kociatkiewicz
University of Essex, UK

INFORMATION SCIENCE REFERENCE
Hershey · New York

Director of Editorial Content: Kristin Klinger
Senior Managing Editor: Jamie Snavely
Managing Editor: Jeff Ash
Assistant Managing Editor: Carole Coulson
Typesetter: Larissa Vinci
Cover Design: Lisa Tosheff
Printed at: Yurchak Printing Inc.

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue, Suite 200
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com/reference

and in the United Kingdom by
Information Science Reference (an imprint of IGI Global)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 0609
Web site: http://www.eurospanbookstore.com

Library of Congress Cataloging-in-Publication Data

Handbook of research on knowledge-intensive organizations / Dariusz Jemielniak and Jerzy Kociatkiewicz, editors.
p. cm.

Includes bibliographical references and index.

Summary: "This book encompasses a wide variety of research approaches and theoretical stances,that are united in their contributions to the study of the burgeoning field of knowledge intensive organizations"--Provided by publisher.

ISBN 978-1-60566-176-6 (hardcover) -- ISBN 978-1-60566-177-3 (ebook) 1. Knowledge management. 2. Organizational learning--Management. I. Jemielniak, Dariusz. II. Kociatkiewicz, Jerzy.

HD30.2.H36429 2009
658.4'038--dc22

2008047746

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book is new, previously-unpublished material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

Chapter XIII
Modelling the New Product Development Process:
The Value of a Product Development Process Model Approach, as a Means for Business Survival in the 21st Century

Jonathan D. Owens
University of Lincoln, UK

ABSTRACT

Success in new product development (NPD) can be considered a general aim for any company wishing to survive in the 21st Century. It has been found that positive effects can result from the existence of formal "blueprints" and "roadmaps" of the NPD process. This chapter discusses numerous NPD processes which can assist a company to capture what it does, and follow a structured development route, from which it is possible to gain a better understanding of how to improve the development process, and thus reap the potential and tangible benefits. This chapter's focus is at organisations that are considering implementing a new product development (NPD) process in order to improve repeatability and ultimately sustainability of their innovative capabilities, a necessary and vital component for survival. It aims to bring an understanding of the underlying characteristics that may contribute to a potential and successful outcome during the development process within organizations, through the adoption of a structured NPD process.

INTRODUCTION

The design and development of products has been, and is continually the focus for many different authors. The pre-occupation with design and development exists because getting it right is so important. A revealing comment from Norman and Peterson (1999, p65) advises why companies are so desperate to understand what they do, and how they can make things better: *"...all good companies can innovate, but fewer are able to be innovative again and again."* No one has been able to capture the ultimate prescription for success, even some of the same authors publish different observations, depending upon the orientation and audience.

WHAT IS A NEW PRODUCT?

There are numerous definitions by various authors (Cooper, 1999, 2001; Cooper *et al*, 1997; Hart, 1996; Ozer, 1999, 2004; Tracey, 2004) however one common similarity characterises a new product as 'one not previously manufactured by a company'. One of the foremost aims of any development programme should be to get the right product or service, to the market or customer as quickly as possible. This can limit the chance of a competitor gaining an advantage by first entry, and therefore one enjoying an early market position. The cost of development, whether large or small, is a burden on the cash flow of an organisation and pressure will be applied for an early payback of cash spent (Hultink and Hart, 1998). For example, marketing functions can expend vast resources, determining which products should be offered to particular markets and at what price. Restrictions on new product scope that are imposed are usually derived from a combination of the mission statement, or strategy of a company and the attractiveness of the market (Cooper and Kleinschmidt, 2000).

THE NEW PRODUCT DEVELOPMENT PROCESS

The potential for innovation is considered to be a fusion of a perceived user needs and a technological opportunity for fulfilment of this need (Jenkins *et al,* 1997). Innovation is often used interchangeably with other words and phrases, or can be used with varying emphasis, depending upon the subjects that are under consideration (Hutlink and Hart, 1998). It has been discussed (Wright and Swain, 1995) that 'innovation' is a term invariably used by research and design people; 'new product development' is a phrase generally referred to more in marketing and management; and 'design' is a common word in engineering. However, to many who are embroiled in the act of NPD, they will note that the three have subtle, but important differences. There appears to be a hierarchy of activities that these phrases encompass. 'Innovation' can be considered as the unit of technological change and an invention, if one exists in the situation, it is part of the process of innovation (Harborne and Johne, 2003). New product development, for all intents and purposes, can be viewed as a slightly less radical phrase such that the development of a 'new' product does not have to involve innovation. New products are different from those, which already exist, in terms of major or minor changes (Noke and Radnor, 2004). The 'newness' may be new creations (such as original innovations; or products new to the world or new to the company); additions, improvements and revisions (with greater emphasis on particular values); repositioning of the product (e.g. novel ways to use it in a different market segment, or possibly the use of branding); or simply cost reductions (lower price, or improvement in through life costs) (Booz, Allen and Hamilton, 1991). Figure 1 illustrates a typology for product 'newness' categories. It is the product design and development that is the interest of this research.

Figure 1. Classification of New Products (Booz, Allen and Hamilton, 1991)

New to the World Products.
These new products are the first of their kind and create an entirely new market. Examples of products in this category are the Sony Walkman and 3M's Post-It notes. This category represents up to ten percent of all new products.

New to the Company.
These are products new to a company, but not to the marketplace, enabling a company to enter an established market for the first time. For example, IBM was not the first to launch an office version laser printer, Hewlett Packard (HP) were, therefore it was not an innovation, but it did however represent a new product line for IBM. Approximately twenty percent of all new products correspond with this category.

Additions to existing Product Lines.
These are new items to a company that fit within an existing product line the company manufactures. They may also represent a fairly new product to the market place. For example, the introduction of HP smaller and considerably less expensive version of its laser printer, that was suitable for home computers. The printer was a new item to the LaserJet line. This product type represents approximately twenty-six percent of all new product launches.

Improvements in revisions to existing products.
These are essentially replacements of existing products. They offer improved performance or greater perceived value over the previous product. Similarly, this product type can represent up to twenty six percent of all new product launches.

Repositioning.
These are essentially new applications for existing products, and involve retargeting an old product to a new market segment for a different application. For example aspirin was considered a standard reliever for headache and fever symptoms, but due to safer, more effective and cheaper products it (aspirin) was superseded. However, new research demonstrated this product had other benefits, and resulted with the aspirin being marketed as prevention against blood clots, strokes and heart attacks. This product type can account for up to seven percent of all new product launches.

Cost Reductions.
These are new products designed to replace existing products in the line, and can yield similar benefits and performance. From a marketing perspective they are not new products but from a design and production perspective, they could represent significant change(s) to the company. This product type can account for up to eleven percent of all new product launches.

However, the driving force for this product innovation may be varied: anything from market and competitor action and reaction; information on customers' needs; technical fine tuning of the process; or entrepreneurial inspiration.

According to Kalyanaram and Krishnan (1997) "Good design" can be achieved when the product not only looks good, but it also does the job well. Indeed, "*design can often add something to a product or service which the customer never expected, thus improving the overall customer experience*" (Cooper, 1999, pg 26). Thus, here 'designing' is differentiated, because it is a tool which can be applied during NPD to help turn an invention into a successful product, or to extend the usefulness of an existing innovation (Osterlund, 1997). Subsequently, NPD is a most appropriate term for this research, because it relies upon "design" activities carried out to deliver a product, which may, or may not, be an "innovation".

In order to undertake NPD, it would be prudent to have a formal blueprint, roadmap, template or thought process for driving a new product project team from the idea stage, through to market launch and beyond (Cooper, 1994). However, as with many other things in the business world, a definitive process that provides continual success has not been forthcoming. This section reviews some of the different models that have been put forward to describe the process and further examines activities, methods and techniques, which have direct relevance to the area of developing quality products.

MODELLING THE NEW PRODUCT DEVELOPMENT PROCESS

Many researchers have found the need to try and capture the progression of the product during development either prescriptively, to inform students and industrialists how it should best be done; or descriptively, to define what actually happens in real life. Also, there are many researchers who discuss the NPD process models and take differing opinions upon what these 'models' actually look like. However, most are in agreement on one thing; that a definitive NPD model which is applicable for every situation cannot be produced.

There are a plethora of examples of different NPD models given by different researchers. Indeed, even in a single study by Cooper (1999) no two product processes were identified as being exactly the same and seven separate general types of processes were outlined from the fifty eight companies involved. Saren (1984) undertook a study of the available NPD process models and classified them into five categories:

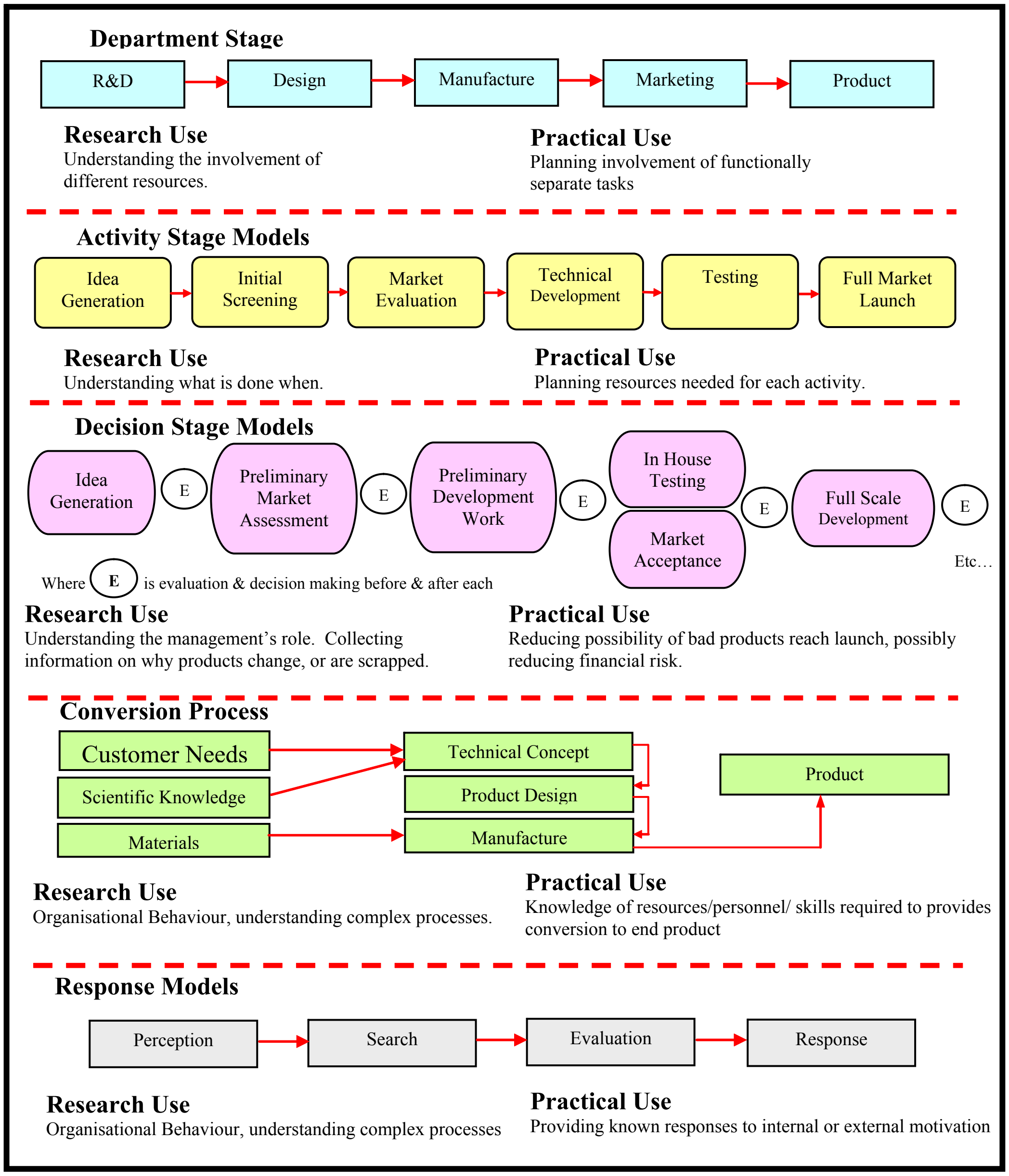
1. Departmental-stage models.
2. Activity-stage models.
3. Decision-stage models.
4. Conversion process models
5. Response models.

Figure 2 provides a summary of these different models by type. Discussion points on the usefulness of each model for research work and their practical use in the management of NPD are also illustrated.

Saren (1984) suggests that dividing methods into groups provides a useful point for an examination of how each model might purposefully be used in research; for example, who is involved in the innovation; at what point and in what order are specified tasks undertaken; upon what basis decisions are made; how inputs to a process become outputs; or the reactions to specified stimuli. However, he concluded that although each individual model is valid, in that it indicates something of the characteristics of the process, more work needs to be done on the holistic process of innovation in companies; this is something that is reiterated in further research carried out by Cooper (2001).

More recent research by Noke and Radnor (2004) uses the nineteen sixties phased development model as a starting point for a comparison with some of the NPD process model ideas which have been progressing from the late nineteen eighties in to the early twenty first century. They also claim that modern stage gate methodologies, product and cycle-time excellence; and total design as the main examples of advancement in processes aimed at improving product success. Since there is a number of different ways to model the NPD process, and each way has associated with it its own specific strengths and weaknesses, this paper will cover those that are recurrent in the most recent literature. Therefore, the following will briefly outline the origins, uses and limitations of five generalised modelling techniques, which are common and progressive:

Figure 2. Summary of some NPD process models (after Saren, 1984)



1. Stage gate models.
2. Multiple convergent process.
3. Product and cycle-time excellence.
4. Total design.
5. Third generation NPD process.

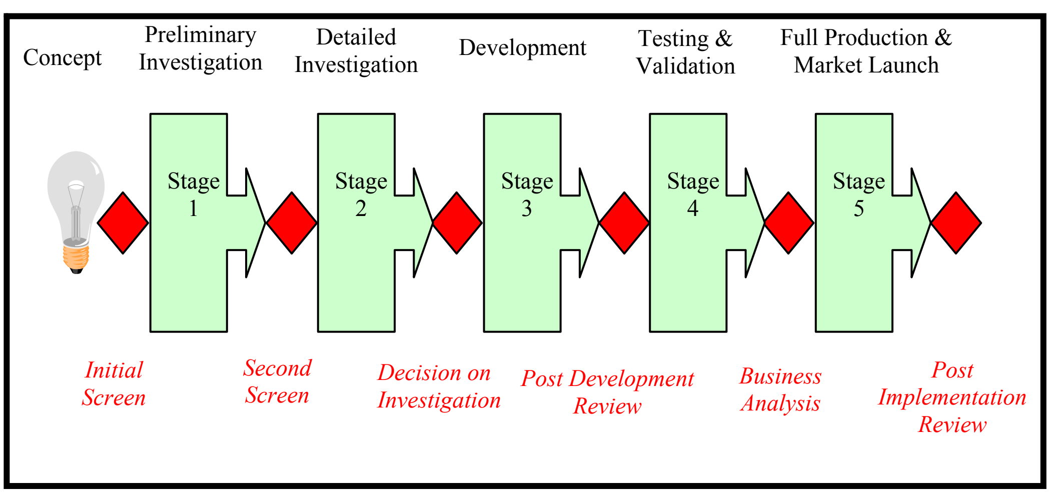
THE STAGE GATE MODEL

The stage gate model takes the process as an alternate series of activity stages followed by decision gates (see figure 3). The decision gate allows or prevents the following activity stage being initiated, depending upon whether it meets the evaluation criteria. At any stage the project may be terminated, suspended or rejected for rework or improvement until it can finally pass the gate. It may even have to go back further, to a previous stage. Therefore, the stage gate process facilitates iteration, with built-in feedback loops in each stage, and among stages (Zhao *et al*, 1999). In recent years some researchers (Baldwin and Clark, 2000; Cooper *et al*, 2002; Gerwin and Barrowman, 2002) have suggested that successful product development is aided by following a stage gate decision process because it encourages activities to be undertaken by a core team of representatives from all functional departments. The stage gate models may help the reader to understand the management of the process and may also help prevent losses made by revealing early on, and before market launch, the products which will fail in an industrial situation by reducing failure risk in the comprehensive review implemented at the gate of each stage (Zhao *et al*, 1999).

However, the model does not lead us to a means of ensuring that the product will meet the need of the user(s), or indeed the final customer. This kind of system does have the potential to include "*go/no go*" decisions, based on whether the product is being designed to a high enough quality and will satisfy the user(s) and ultimately the customer. On the other hand, without elucidation from someone providing a customer needs compliance emphasis, there is not necessarily any strong incentive to use this as a basis for what the product "*must meet*" or "*should meet*" when product management decision are being made at each of the gates.

Although some forms of this model can be seen widely in practical use today in some industrial organisations (Owens and Davies, 2000; Owens, 2004a) there are some general problems which occur when following a stage gate model which are indicated by Cooper (1999). Cooper adds later (2001) that even though the idea has been taken up in the last decade with positive effect, stage gate process models are still not really usable because they are too time consuming, often have too many ways of waiting time, are too bureaucratic and have no provision for focus. Also, one author (Himmelfarb, 1992, p.10) provides a fairly severe and emotive set of comments by claiming that it "*creates products that are hard to make, that cost too much, that require too many expensive design changes, and that may or may not meet*

Figure 3. Overview of a Stage-Gate NPD process (after Cooper, 2001)

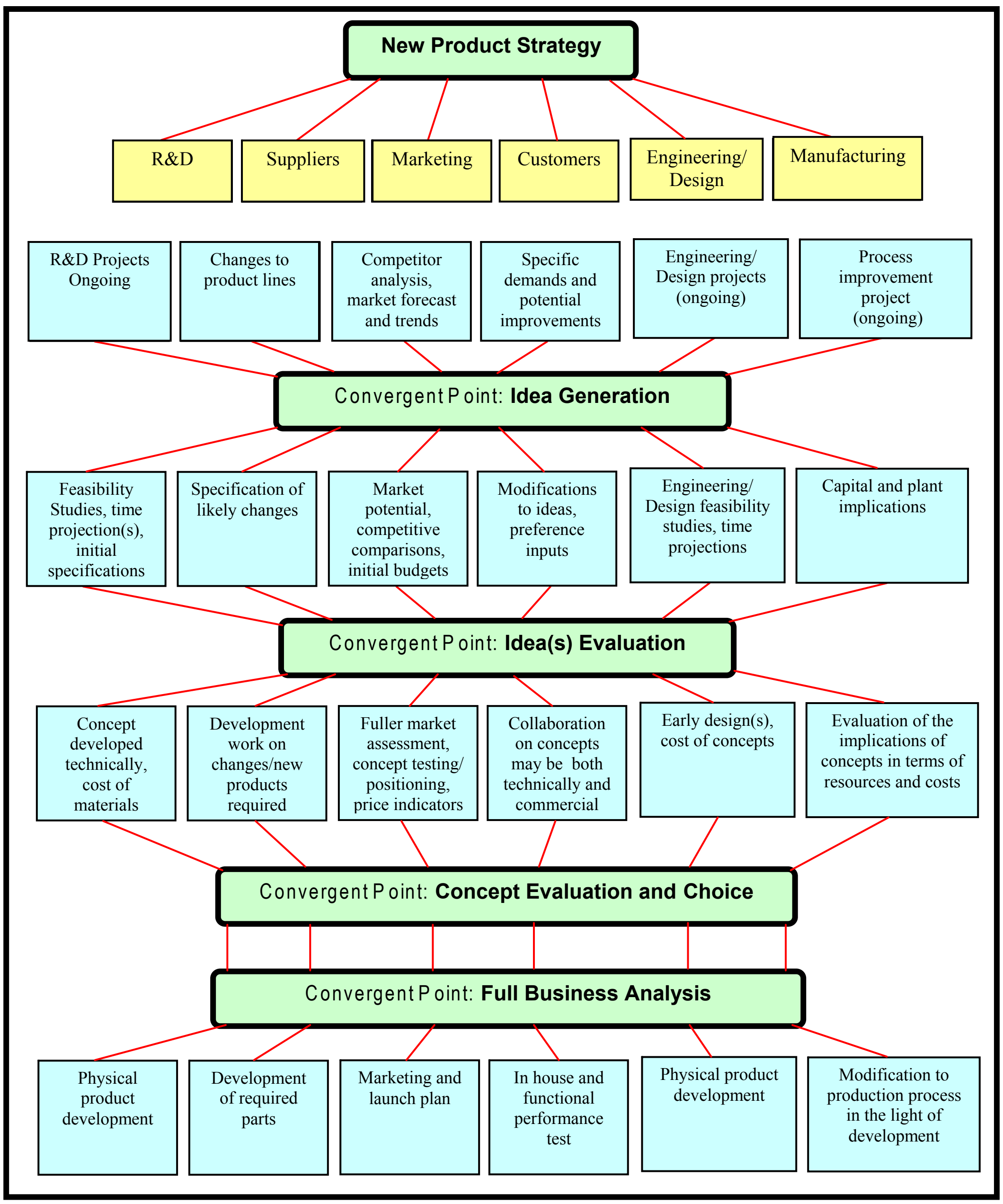


marketplace needs. It encourages isolation of functional areas and, worst of all, it is very slow." All of these observations do not bode well for the extra and important inclusion of both usability and customer needs compliance in this particular process model.

MULTIPLE CONVERGENT MODEL

Problems of the stage gate model and other linearly defined process models have been recognised by those who have been researching the interaction of the process and the people involved with them

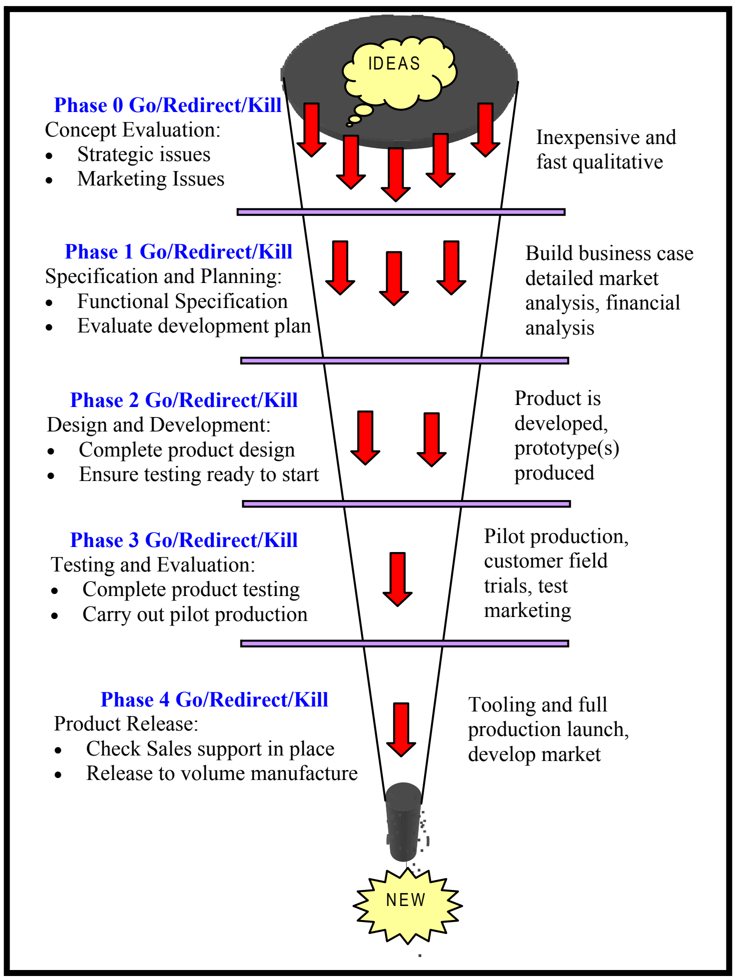
Figure 4. The early stage of the multiple convergent model (after Hart and Baker, 1996)



(Hart, 1996; Griffin, 1997; Shenhar, 2001; Hart *et al,* 2003). The multiple convergent model aims to directly and explicitly integrate people into the process and overcome the reported shortcomings in other NPD process models (Hart, 1995; Hart and Baker, 1996).

The model takes into account the lessons learned from reports in literature that suggest success comes from having quality inputs that are valid from multidisciplinary areas. There is much importance placed on the use of networks and the production of a model that breaks down multidisciplinary boundaries (Hart and Baker, 1996). The model views NPD as tasks with areas leading towards a common conclusion, but are required to come together at a number of different natural and integrative points for evaluation, as illustrated in figure 4. In this way the multiple convergent model is similar to the stage gate models. However, where it differs is that the convergent model has multiple points, which it recognises as important to an iterative process. According to Hart (1995) the advantages of taking the process as a series of converging points for evaluation, followed by diversion into functional activities are:

Figure 5. The phase review process within the product and cycle time excellence model (after Jenkins et al, 1997)



- It accommodates iteration.
- It allows for iterative communication and evaluation within the functional groups.
- The framework can accommodate third parties easily.
- Methods for real integration of work from functional groups can be provided in the convergent points.

Despite the model being driven by converging points, the main disadvantage in practical use appears to be, ironically, that it may be too divergent. It converges for cross-functional decisions, but then separates out into each of the different functions to carry out the tasks. Hart *et al* (2003) describe a key element as the amount of information sharing that is modelled, however, horizontal communications between functional areas, are only modelled as happening during the evaluation or collation points and not during other activities. With so many points of convergence during the process, this model does not appear to be conducive with efficiency and it seems to require a large amount of management effort to keep the process on track.

PRODUCT AND CYCLE-TIME EXCELLENCE MODEL

In contrast to the multiple convergent model, there are models that have been developed which are driven by the need to reduce time to market. These models concentrate on the control of economics of the design process. One such example is that of the product and cycle-time excellence model developed by Pittiglio Rabin and McGrath (McGrath *et al,* 1992). This particular model follows a stage gate analogy, with ‘phase reviews’ providing the decision points, at which the project should continue to go on, be redirected or terminated. However, during phase reviews the decisions are not made by the multidisciplinary core team carrying out the work, as with multiple convergent theory, but a group of four or five senior managers known as the ‘Product Approval Committee’ (Robinson and Chiang, 2002). Under product and cycle time excellence, the process is seen as a funnel taking in lots of ideas, following the completion of five phases, producing new products, as illustrated in figure 5. In an attempt to reduce the time it takes to develop a new product, the productivity model breaks down each of the five phases in the process into fifteen or twenty steps and then each of these steps into ten to thirty tasks. Database records can be kept on the timing for each of the tasks and thus the total development time can be judged for each new product (Suomala and Jokioinen, 2003).

The productivity and cycle time concepts also pay attention to the management of the process in more holistic ways. According to Jenkins *et al* (1997) of the seven major elements for this model, four are directly overseeing the whole of the product development process in the company:

1. The provision of core teams during development
2. The use of a product strategy
3. The review and correct implementation of technology management
4. The endorsement of cross project management

The authors of the product and cycle time excellence model also advocate the use of design techniques and automatic development tools that will help focus and streamline the development of the product (McGrath *et al,* 1992).

The product and cycle time excellence model is more than just a definition of the development process. It is aimed at efficiently managing the development of new products such that the product is produced on time and within budget, whilst using the optimum balance of skills and methods at the right point during the projects’ progression (Lynn and Akgun, 1999). However, these types of models, which are driven by productivity and cycle time reduction, rely upon putting senior management in an overriding position of authority and also upon splitting down the design process to a level so low that it can be timed. As well as the obvious philosophical discussions about specifying exactly the creative nature of design that these issues incite, both of these ideas seem regressive and are reminiscent of the work-study principles, based on Taylorism, which had its 'glory days' at the beginning of the twentieth century.

TOTAL DESIGN

"Total design is seen as a broadly based business activity in which specialists collaborate in the investigation of a market, the selection of a project, the conception and manufacture of a product, and in the provision of various kind of user support." (Pugh and Moreley, 1988, p1)

The models discussed revolve around breaking down the process into manageable portions by seeing the development process as a series of problems to be solved (Wright, 1998). Various authors (Cooper and Edgett, 2003; Hart *et al*, 2003; Griffin, 1997) have criticised the way of focussing on parts of the problem and solving them one-by-one because they have found that they are often used without paying sufficient attention to the aspects of assimilating all of the problems together. A slightly different outlook to view design and development as a converging spiral, the spiral from the design process attempts to emulate real-life, in that the design process is evolving (Oakley, 1990). The spiral moves from a formulations stage, to an evolution stage, through to a stage where transfer takes place and is followed by a reaction stage that returns the development to the formulation stage, as illustrated in figure 6. This is different to other series or stage gate models as it relies upon interactive and overlapping stages that evolve.

The spiral form was a depiction used for Acar's (1966) triple-helix model of the product development process that can be cross-sectioned at any point to reveal the interaction between

Figure 6.

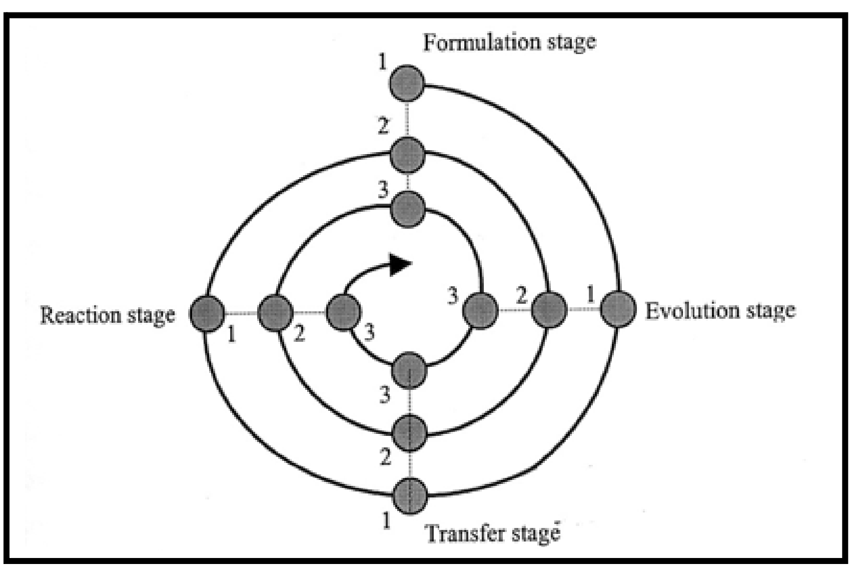
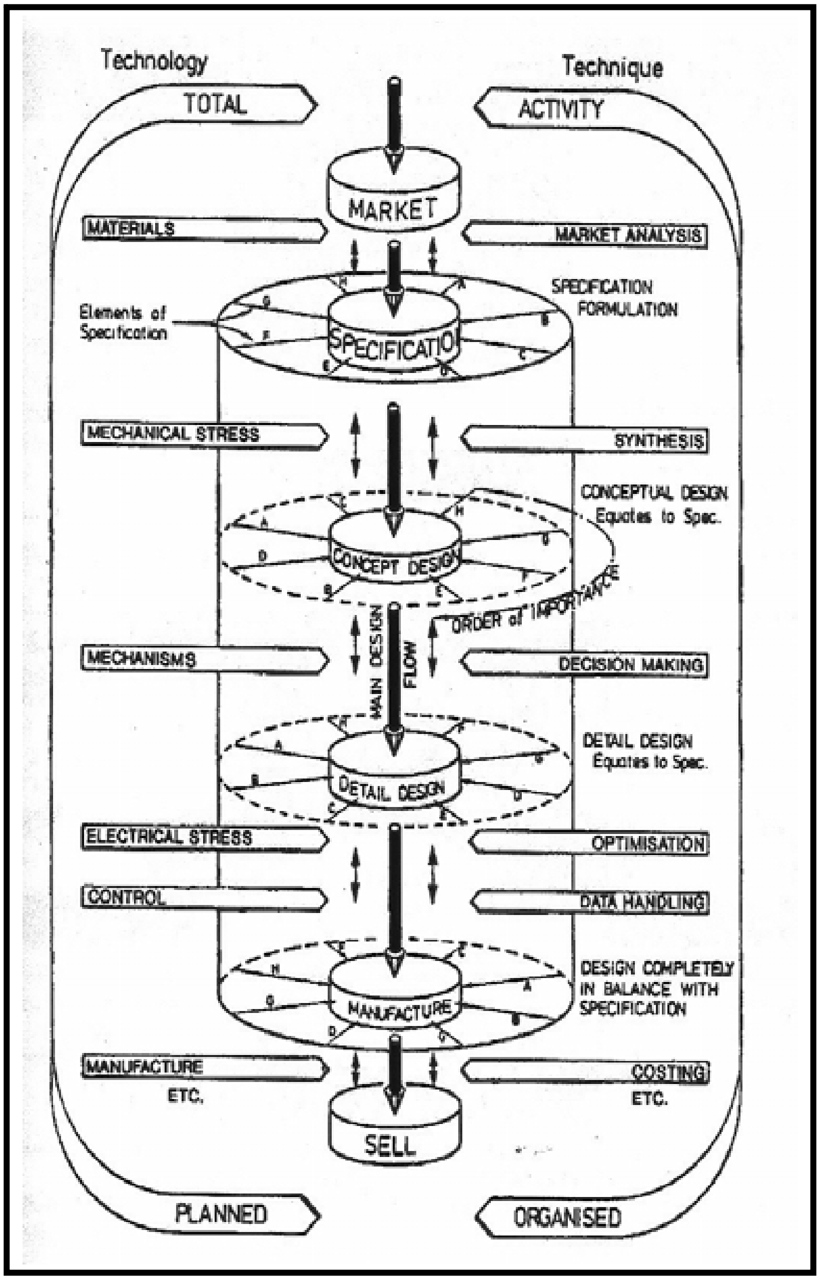


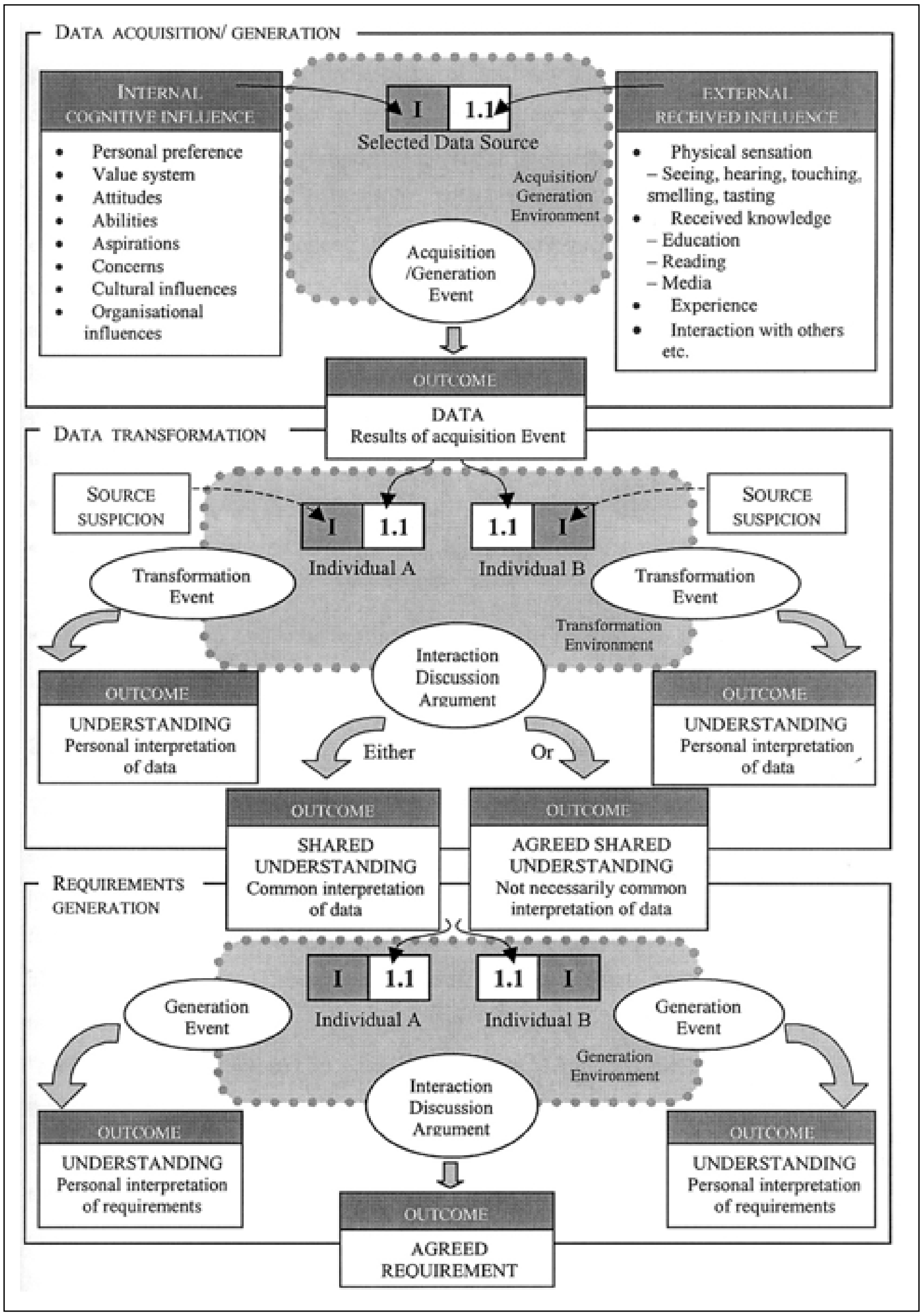
Figure 7. The total design activity model (Pugh, 1991, p11)



specification, conceptual design and embodiment design. In the total design model championed by Pugh and his colleagues, the spiral is taken into more depth (Pugh, 1991; Pugh and Moreley, 1988; Hollins and Pugh, 1990).

The development of the total design model and subsequent publishing of Pugh have stimulated much discussion within engineering design circles (Pugh and Moreley, 1988; Pugh, 1991; Hollins and Pugh, 1990; Jenkins *et al*, 1997). Also, the total

Figure 8. Theoretical requirements capture process model (Cooper et al, 1998, p 510)



design philosophy is taught as a useful and useable model of best practices on a number of UK higher education institutes' engineering courses, especially because it emphasises the use of many different discipline independent tools and methods (Wright, 1998).

The total design model outlines six nominal spirals, which attempt to capture the main undertakings during the design process, all within an iterative environment. These "design cores" are presented by Pugh (1991) as:

- Investigation of market/user needs and demands
- The development of the product design specification
- Conceptual design
- Detailed (technical) design
- Manufacture
- Selling (marketing)

Figure 7 illustrates how Pugh visualises the whole package of design activities, within a "…framework of planning and organisation…and how they fit into a business structure" (Pugh, 1991, p8).

The total design and its embellishment with detailed information on how to approach each of the "design cores" goes a long way to assist engineering designers practically undertake product design systemically. Pugh and his colleagues have devoted much literature (Pugh and Moreley, 1988; Pugh, 1991; Hollins and Pugh, 1990) to explaining methods and tools that can be used in conjunction with the total design philosophy. The model does acknowledge and capture many of the complexities of NPD and attempts to attract a cross discipline audience. It also explicitly acknowledges the place of design within the company's structure and long-term strategy (Sethi, 2000). However, much of the work is essentially a model and text for engineers, and gears itself more towards explaining business requirements to a technical audience, rather than explaining technical issues to a business audience.

The market and user needs "design core" does not clarify well enough for an inexperienced company or researcher to fully comprehend the importance of meeting customer needs to the success of the product. However, having said that, there are numerous issues that have arisen from studying this approach, such as the strong emphasis on the Product Design Specification (PDS) and the recognition of informal paths of communication within the design team, which have directed some of this particular research and will be discussed in the following section of the thesis.

REQUIREMENTS CAPTURE PROCESS MODEL

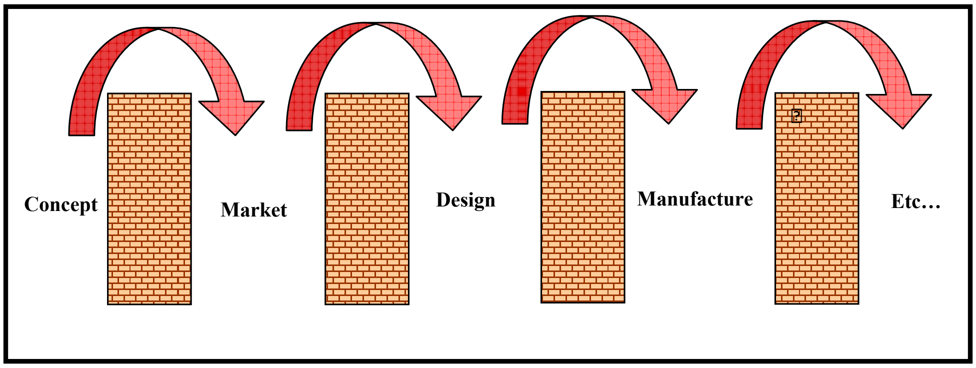
Cooper *et al.* (1998) have produced a theoretical model of the requirements capture process and have included the aspects of individual and group understandings for customer requirements, this is illustrated in figure 8. They discuss both internal and external variables that can influence the personal interpretation of data. They look at the outcomes of three levels:

1. Acquisition of data
2. Transformation of data
3. Generation of requirements

They concentrate upon considering the situation where individuals come together to gain a shared understanding of customer needs, and then generate an agreed requirement. Cooper *et al's* (1998) is important, because it deals with the handling of customer information and the definition by the NPD team of requirements for the customer. Issues that are addressed in the model, that are particularly pertinent to this research are:

- Different views and understandings (perceptions) of the same data are included
- Activities and events change the understating (perception) of a customer requirement(s)
- Data acquisition and transformation events are required to gain an agreement on the definition of a product requirement(s)

Figure 9. "Over the wall" Concept (after Gehani, 1996)

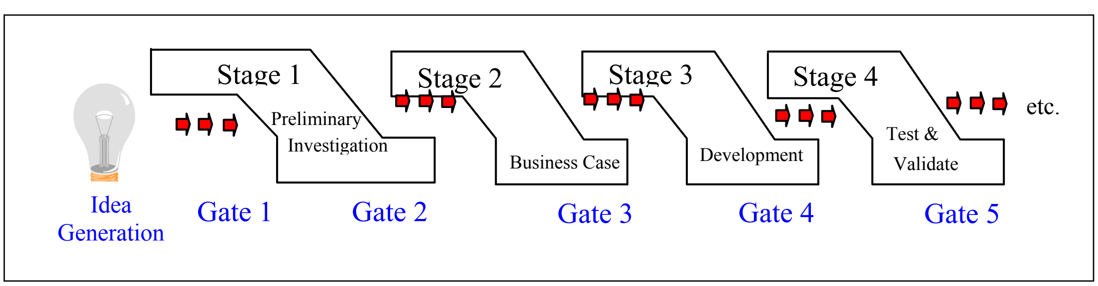


THIRD GENERATION NEW PRODUCT PROCESSES

The phase development models of the nineteen-sixties are referred to as the first generation of defined product processes (Dillon *et al*, 2005). The phase review process advocates sequential development stages, each carried out by different functional groups that complete their phase then pass on the results to the next phase and function (Ahmed, 1998). First generation development processes are often referred to as "*over the wall*" (illustrated in figure 9) processes because development is handed onto the next group, when the last has finished, with an obvious lack of interaction between each phase (Gehani, 1996). The second generation of product development processes are the processes of today – which are mainly based upon stage gate type models involving a cross discipline structure of one type or another. According to Cooper (2001) the third generation are the future way in which products should be produced. He suggests third generation processes are relatively inadequately defined because they are still in development and should be developed and grown around the specific company. They are driven by the need to efficiently create new products and get them to market as quickly as possible, but with a much greater tolerance for calculating risk taking, which is a conflicting view to that of the previously discussed models driven by cycle time.

Cooper *et al* (2002) suggests there is a distinct need to redress the balance from a restrictive linear process that only moves the product development forward when a decision is made on the outcome

Figure 10. Third generation process (Cooper, 2001)



of a preceding activity, as illustrate in figure 10. The ideas put forward by these third generation models tie in with the management practices of concurrent and simultaneous engineering.

This model would, inevitably require integration through software, hardware and 'human ware' or team facilitation (Sethi, 2000; Reid and Brentani, 2004). It will allegedly work from a premise that attempts to maintain discipline, but allows a balance of action thoroughness and the need to move quickly (Cooper and Edgett, 2003). To answer problems that may arise from this basis of reasoning, four fundamental 'F's' have been defined (Cooper, 2001):

1. **Fluidity**. The model is fluid and adaptable, with overlapping and fluid stages for greater speed.
2. **Fuzzy Gates**. The model features conditional go decisions (rather than absolute ones), which are dependant on the situation.
3. **Focused**. The model builds in prioritisation methods that look at the entire portfolio of projects (rather than one at a time) and focuses resources on the "best bets".
4. **Flexible**. The model is not a rigid stage gate process, each project is unique and has its own routing through the process.

The implications from the use of such a model is that everything becomes so much more difficult to define in absolute terms, making devising and understanding the product development process a more daunting task (Zollo *et al*, 2002). As a project progresses, the decisions made will be more complex and sophisticated and may be hard to place in context if the stages overlap too readily (Gerwin and Ferris, 2004). Thus, falling into an ad-hoc, free-for-all system of product development seems a distinct possibility. Cooper (2001) has also made some of these observations and suggests that this model will only work within a framework based on the second-generation stage gate models. He does not advocate a withdrawal from stages and gates, instead he realises that to make these systems really work, product development must allow much more flexibility. A potential way of achieving this could be a move towards reducing the authoritative role of senior management and pushing the decision-making role of the NPD project team members and leaders.

DISCUSSION: THE USEFULNESS OF A PRODUCT DEVELOPMENT PROCESS MODEL APPROACH

The previous discussions provide a good example of the abundance and variation in the different ways of modelling the product development process. It is by no means exhaustive, but rather reflects upon the importance of the diversity that exists in this one area alone. The necessity to examine these different types of models and ways of describing the product development process is that of practicality. For example, if one can somehow capture what it is one's company does, and can follow the path the product development process takes, then one could have a better understanding of how to improve the process and can reap tangible benefits. It has been found that positive consequences result from the existence of formal NPD processes (Cooper *et al,* 2002; Harborne and Johne, 2003; Wong, 2002). Also, research (Cooper, 2001; Gehani, 1996; Reid and Brentani, 2004; Meyer *et al*, 2005; Sethi, 2000) has suggested that the lack of understanding and implementation of product development processes in industry can account for poor product development performance.

Since many product development authors and practitioners have reported these positive results, it is no wonder that they are driven to try and capture the essence of good product development practices and processes. Therefore, in an effort to make the task of modelling the process more manageable, different authors have tried to summarise their complexities by generalising

Figure 11. Model of the need assessment process (Holt et al, 1984)

Need Identification	A problem or a user need is perceived, often in a vague form. This is usually the initiation of the product innovation process.
Need Evaluation	Based on available information, the perceived need is analysed and evaluated; for example in connection with preparation of the proposal.
Need Clarification	This involves a systematic study of the user needs involved. It may be undertaken in connection with a feasibility study in the last part of the idea generation stage.
Need Specification	Based on assessed needs and their relative strength, relevant need requirements are specified.
Need Up-Dating	As the project moves ahead, the needs specified are up-dated at intervals in connection with development of the technology and planning of the marketing and manufacturing operations.

and minimising differences between companies and products (Noke and Radnor, 2004). However, because of this the models are often only a representation of the process and are regularly produced by individual researchers as tools to investigate specific phenomenas that occur during product development. Also, the reality of producing working models is the consideration of differences, which occur between what the literature describes and/or prescribes and what is actually done in reality because the nuances within each company are so difficult to encapsulate (Cooper *et al,* 1998).

Given the plethora of product development models available and reviewed here, it would be reasonable to assume that there would be one, which specifically follows a customer's need through product development. However, although many pay more than just 'lip-service' to customer needs. None have been found that depict the whole of the process for NPD, with explicit emphasis on customer needs compliance. The closest is a descriptive list suggested by Holt *et al* (1984). Their list of stages during which different user needs issues are addressed is illustrated in figure 11. This is a useful list, and does highlight different periods of need recognition, assessment and appraisal. Yet, it does not get to grips with the essence of product development interaction, process, iteration and communications required. These are issues that must first be identified by the company in order to be able to understand at least some of the facets of customer needs compliance during the product development process.

CONCLUSION

In summary, from the discussions it is apparent various investigators have provided a lot of different methods for depicting the NPD process. It has examined the areas of product definition, NPD process modelling and activities, together with a discussion of management issues and matters of information production and use during product design. In short, it has explained some of the principles involved and concepts that are generally referred to in the field of NPD and marketing. However, thus far, none of the methods have been specifically developed for following customers' needs through the NPD process from concept to launch.

The representation of the linkages within NPD practice these models demonstrate a useful starting point for further examination and research, as long as they are taken within their context and understanding of their limitations.

It is evident there is much anecdotal evidence, postulation and idea generation around the area of NPD processes and designing new products. Yet it also indicates the lack of research that has been specifically carried out, that looks at customer needs during NPD. The requirement for further study is evident in a number of particular areas:

- Customer needs literature is mainly restricted to marketing and marketing research literature. There is little research in engineering and design that acknowledges the importance of the customer as the end recipient of the product's quality.
- There is much NPD literature that concentrates upon the general NPD and, in particular, the success and failure of products, broad NPD processes and the overall management of new product ideas. However, specific attention to the customer during success or failure, NPD process, or management of design is minimal.
- There are no apparent NPD modelling methods that have been specifically designed to capture and show the development of new products to meet customer needs requirements. Those models that are available may be used as a basis, but definition of how and what should be modelled to capture information on these aspects is required.
- It has been discussed that the most successful companies undertake both marketing and technical activities well. It has been noted that good market research is a key to achievement, together with practical application of quality techniques. However, little empirical casework has been carried out to discover the effect these issues may have upon customer needs compliance and customer satisfaction.
- The strategy and structural linking mechanism adopted at company and project level has been discussed in the management literature, but still little empirical studies in design research acknowledge links between strategically valuable NPD processes and the customer needs.
- The production, transfer and use of information on customer needs has been included by a number of authors. However, Hart (1995) notes that much research is still warranted into how information is generated and what contingencies might affect information-gathering activities. Also, Davis (2002) identifies numerous areas worth researching with respect to information and knowledge presentation within the design process during NPD.
- A quality gap has been recognised and discussed by previous researchers. However, there is certainly a requirement for more empirical research to investigate the role of the perceptions that the designers have of the product's quality during NPD.

Subsequently, there are numerous gaps in the current NPD research, and therefore, potentially a large number of definitive areas for research in the field of customer needs compliance, product quality and NPD. However, much of the work undertaken by previous authors can be used as a basis to start a novel project.

REFERENCES

Acar, B. S. (1966). A new model for the design process. *Proceedings of the Institute of Mechanical Engineers, Series E*(210), 135-138.

Ahmed, P. X. (1998). Culture and climate for innovation. *European Journal of Innovation Management, 1*(1), 30-43.

Akgun, A. E., Lynn, G. S., & Byrne, J. C. (2004). Taking the guesswork out of new product development: how successful high-tech companies get that way. *The Journal of Business Strategy, 25*(4), 41-48.

Beard, C., & Easingwood, C. (1996). New Product Launch: Marketing Action and launch tactics for high technology products. *Journal of Industrial marketing Management, 25*, 87-103.

Booz, A., & Hamilton (1991). *New Product Management.* New York, USA: Booz, Allen and Hamilton Inc.

Cooper, R. G., & Kleinschmidt, E. J. (1996). Winning businesses in product development: The critical success factors. *Research Technology Management, Jul/Aug, 39*(4), 18-30.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (1997). Portfolio management in new product development: Lessons from the leaders – Part I. *Research Technology Management, Sep/Oct, 40*(5), 16- 30.

Cooper, R. G., & Kleinschmidt, E. J. (2000). New product performance: What distinguishes the star products? *Australian Journal of Management, 25*(1), 17-46.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2002). Optimising the stage-gate process: What best practice companies do – II. *Research Technology Management,* Nov/Dec, *45*(6), 43-51.

Cooper, R. G., & Edgett, S. J. (2003). Overcoming the crunch in resources for new product development. *Research Technology Management, 46*(3), 48-59.

Cooper, R., Wooton, B., & Bruce, M. (1998). Requirements Capture: Theory and Practice. *Technovation, 18*(8/9), 497-511.

Cooper, R. G. (1994). Perspective: Third generation new product processes. *Journal of Product Innovation Management, 11*(1), 3-14.

Cooper, R. G. (1999). From Experience: the invisible success factors in product innovation. *Journal of Product innovation Management, 16*(4), 333-351.

Cooper, R. G. (2001). *Winning at New Products: Accelerating the process from idea to launch*, 3rd Edition. Perseus Books.

Dillon, T. A., Lee, R. K., & Matheson, D. (2005). Value Innovation: Passport to wealth creation. *Research Technology Management, 48*(2), 22-36.

Gehani, R. R. (1996). Concurrent product development for fast track corporations. In S. J. Hart (Ed.), *New product development* (pp. 184-197). Dryden Press.

Gerwin, D., & Barrowman, N. J. (2002). An evaluation of research on integrated product development. *Management Science, 47*(7), 938-953.

Gerwin, D., & Ferris, S. J. (2004). Organising New Product Development Projects in Strategic Alliances. *Organisation Science, 15*(1), 22-38.

Griffin, A. (1997). PDMA research on new product development practices. *Journal of Product Innovation Management, 14*(6), 429-458.

Harborne, P., & Johne, A. (2003). Creating a project climate for successful product innovation. *European Journal of Innovation Management, 6*(2), 118-133.

Hart, S. J., & Baker, M. J. (1996). The multiple convergent processing model of new product development. In S. J. Hart (Ed.), *New Product Development* (pp 151-166). London: TheDryden Press.

Hart, S. J., Hutlink, E., Tzokas, N., & Commandeur, H. (2003). Industrial Companies' Evaluation Criteria in new Product Development gates. *Journal of Product Innovation Management, 20*(1), 22-36.

Hart, S. J. (1995). Where we've been and where we're going in new product development research. In M. Bruce & W. G. Biemens (Eds.), *Product development – Meeting the challenge of the design-marketing interface* (pp. 13-43). Chichester, UK: John Wiley and Sons.

Hart, S. J. (1996). *New Product Development: A Reader.* The Dryden Press, Harcourt Brace and Company Limited.

Himmelfarb, P. A. (1992). *Survival of the fittest – New product development during the 90's.* Englewood Cliffs, NJ, USA: Prentice-Hall International.

Hollins, W., & Pugh, S. (1990). *Successful product design*. London, UK: Butterworth.

Holt, K., Geschka, H., & Peterlongo, G. (1984). *Need assessment – A key to user orientated product innovation.* John Wiley and Sons Ltd.

Hultink, E. J., & Hart, S. (1998). The world's path to the better mousetrap: myth or reality? An empirical investigation into the launch strategies of high and low advantage new products. *European Journal of Innovation Management, 1*(3), 106-121.

Jenkins, S., Forbes, S., Durrani, T. S., & Banerjee, S. K. (1997). Managing the product development process [Part I: An assessment]. *International Journal of Technology Management, 13*(4), 359-378.

Jobber, D. (1998). *Principles and Practice of Marketing,* Second Edition. McGraw-Hill Publishing Company, International Editions.

Kalyanaram, G., & Krishnan, V. (1997). Deliberate product definition: Customising the product definition process. *Journal of Marketing Research, 34*(2), 276-286.

Li, T. (1999). The impact of the marketing-R&D interface on new product export performance: A contingency analysis. *Journal of International Marketing, 7*(1), 10-34.

Lynn, G. S., & Akgun, A. E. (1999). Launch your new products/services better, faster. Research Technology Management, 46(3), 21-26.

McGrath, M. E., Anthony, M. T., & Shipiro, A. R. (1992). Product development: Success through cycle time excellence. PRTM Butterworth-Heinemann Publishing.

Meyer, M. H., Anzani, M., & Walsh, G. (2005). Innovation and Enterprise Growth: It took courage, focus and commitment at all levels for IBM to develop its next-generation product lines. *Research Technology Management, 48*(4), 34-44.

Noke, H., & Radnor, Z. J. (2004). Navigating innovation: a diagnostic tool supporting the process. *Journal of Manufacturing Technology Management, 15*(2), 172-185.

Norman, P. A., & Peterson, T. (1999). Quality improvement through innovation. In S. K. Ho (Ed.), *TQM and Innovation Proceedings of the fourth international conference on ISO 9000 and TQM* (pp 64-70). HKBU press.

Oakley, M. (1990). Design and design management. In M. Oakley (Ed.), *Design management: A handbook of issues and methods* (pp 3-15). Oxford, UK: Basil Blackwell Ltd.

Osterlund, J. (1997). Competence management by informatics in R&D: The corporate level. *IEEE transactions on Engineering Management, 44*(2), 135-145.

Owens, J. D. (2004a). An evaluation of Organisational groundwork and learning objectives for New Product Development. *Journal of Enterprising Culture, 12*, 303-325.

Owens, J. D. (2004b). World Class Supply: Is it just a question of effective partnership? *Management Services Journal, 48, 8-15.*

Owens, J. D., & Davies, J. (2000). The Importance of a New Product Development (NPD) Process: Getting Started. *First European Conference on Knowledge Management*, Bled School of Management, Bled, Slovenia, 26-27 October.

Ozer, M. (1999). A Survey of New Product Evaluation Models. *Journal of Product Innovation Management, 16*, 77-94.

Ozer, M. (2004). Managing the selection process for new product ideas. *Research Technology Management, 47*(4), 10-15.

Pugh, S., & Moreley, I. E. (1988). *Total Design: Towards a theory of total design and Total Design: Some questions and some answers.* Design division, University of Strathclyde, UK.

Pugh, S. (1991). *Total design – Integrated methods for successful product engineering.* UK: Addison-Wesley Publishing.

Reid, S. E., & Brentani, U. de (2004). The fuzzy front end of the new product development for discontinuous innovations: a theoretical model. *Journal of Product Innovation Management, 21*(3), 170-198.

Robinson, W. T., & Chiang, J. (2002). Product development strategies for established market pioneers, early followers, and late entrants. *Strategic Management Journal, 23*(9), 855-864.

Saren, M. A. (1984). A classification and review of models of the intra-firm innovation process. *R&D Magazine, 14*(1), 11-24.

Sethi, R. (2000). New product Quality and Product Development Teams. *Journal of Marketing, 64*(2), 1-14.

Shenhar, A. J. (2001). One size does not fit all projects: Exploring classical contingency domains. *Management Science, 47*(3), 394-414.

Suomala, P., & Jokionen, I. (2003). The pattern of success in product development: a case study. *European Journal of Innovation Management, 6*(4), 213-227.

Tracey, M. (2004). A holistic approach to New Product Development: New Insights. *Journal of Supply Chain Management, 40*(4), 37-56.

Wong, V. (2002). Antecedents of international new product rollout timeliness. *International Marketing Review, 19*(2/3), 12-132.

Wright, I. C., & Swain, E. (1995). New product engineering: The quality paradox. *Journal of Engineering Design, 6*(1), 49-56.

Wright, I. C. (1998). *Design Methods in engineering and product design*. UK: McGraw Hill.

Zhao, Z., Yap, C. M., & Ang, B. W. (1999). A framework for facilitating quality tools' applications in new product development. In S. K. Ho (Ed.), *TQM and Innovation proceedings of the fourth international conference on ISO 9000 and TQM* (pp. 455-461). HKBU press.

Zollo, M., Reuer, J. J., & Singh, H. (2002). Interorganisational routines and performance in strategic alliances. *Organisational Science, 13*(6), 701-713.

KEY TERMS

New Products: There are numerous definitions however one common similarity characterises a new product as 'one not previously manufactured by a company'.

Innovation: "Innovation' can be considered as the unit of technological change and an invention, if one exists in the situation, it is part of the process of innovation.

Newness: 'Newness' may be new creations, such as original innovations; or products new to the world or new to the company. Additions, improvements and revisions, with greater emphasis on particular values. Repositioning of the product, for example, novel ways to use it in a different market segment, or possibly the use of branding. Cost reductions, lower price, or improvement in through life costs.

New Product Development: New Product Development (NPD) is the term used to describe the complete process of bringing a new product or service to market. There are two parallel paths involved in the NPD process: one involves the idea generation, product design, and detail engineering; the other involves market research and marketing analysis.

Product Development: The development of new, improved, or replacement product or service