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A Conceptual Analysis on the different approaches to New product Development and the Variables Associated with modelling the process.

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Abstract

Globally, new products are launched almost every day. They are developed to provide solutions to common or specialised problems; to enrich our lifestyle; to release us from mundane and monotonous jobs; to give reliable alternatives to old solutions; to amuse us; to provide items that are more pleasing to the eye; to be more ecologically aware etc. What the companies that develop, design, manufacture, market and sell these products are seeking is commercial compensation in the short, medium or long term "success" however you measure it. Subsequently, New Product Development is a major issue for most companies as they seek to reduce time to market, reduce the development cycle, access new technologies and develop more and better products and services. As the development of such new products that can successfully compete in local, national and global markets has thus become a key concern for the majority of companies, so successful NPD is now being seen as a fundamental to both stimulating and supporting economic growth. It is therefore a subject, which has received and continues to receive much attention, particularly in seeking to improve its effectiveness and efficiency. Therefore, paper reviews the New Product Development (NPD) process and considers the variables associated with the different approaches, which may be needed when developing a new product.

Keywords
New Products, New Product Development, New Product Development Processes, New Product Development Modelling, New Product Introduction.

Introduction

In the hotly competitive global environment of the twenty-first century New Product Development (NPD) is being seen as a major consideration for most organisations (Cooper, 2011, 2008; Dillon *et al*, 2005; Song and Benedetto, 2008; Smith, 2011; Schmidt *et al*, 2009). Across the global business arena, it is seen as one of the key areas for focus, as companies seek to reduce time-to-market, access new technologies in order to develop more and better new products and services. As the development of such new products and services which can compete in local, national and global markets has thus become a key concern for most companies, so successful NPD is now more than ever being seen as a fundamental business tool to stimulating and supporting economic growth (Owens and Atherton, 2015). It is therefore a subject that has received and continues to receive much attention, particularly in seeking to improve effectiveness and efficiency. Therefore, this paper reviews the New

Product Development (NPD) process and considers the variables associated with the different approaches that could be considered when developing a new product.

Developmental and Importance of New Products

Various researchers (Beard and Easingwood, 1996; Cooper and Edgett, 2003; Akgun *et al*, 2005; MacCormack *et al*, 2012) have identified NPD as a critical element of business strategy for most companies. Even companies that do not wish to grow will still be at risk from competitors, new technologies and the changing needs of customers if NPD is not undertaken (Cooper, 2011). The industrial revolution changed the social-economic structure of Britain and the world. Prior to this, products were usually made and sold within a region, customer needs were easily communicated between the parties involved (as everything was virtually hand-made and made-to-order) and flexibility and uniqueness were almost certain. Investment in machinery and large factories prompted the development of new towns and cities. No area in Britain reflects this more than Lancashire with its cotton mills, where the customer and vendor operated geographically and relied upon brief descriptions and third parties to produce a marketable product. Mass production reduced the standard cost of products and opened the market to more customers. Henry Ford was the first great global exponent of this in 1913 with the production of the Ford Model T. Other automotive manufacturers adopted mass production techniques and although the motorcar was still a luxury item then, it became more accessible to a wider market. Technological advances, customer preferences and economic developments have changed the automotive industry into a highly competitive market. Research and development departments are constantly looking for variants, modifications and improvements that will attract a larger portion of the market (Li, 1999; Petrie, 2008). As a result, companies that do not adapt to and satisfy customers' needs generally fail (Cooper and Kleinschmidt, 2007; Gerwin and Ferris, 2004). The automotive industry is not unique in having to constantly change; indeed, most industry sectors are under increasing pressure to modify and improve their product ranges (Van Echtelt *et al*, 2008). Competition dictates that a larger share of, or the maintenance of a current position in the market place, will only be achieved by offering a more attractive product (Jobber, 2009; Wagner and Hoegl, 2006).

The Sourcing of New Product Ideas.

The idea for a new product can originate from many sources (Cooper, 2011); for example, customers, employees, current products, competitors etc. The problem occurs in determining which products to develop and which to avoid. The risk of failure should not discourage the introduction of new products, however, though careful product screening should be utilised throughout when instigating development (Balasubramanian and Baumgardner, 2004; Holstrom *et al*, 2006; Johnsen, 2011). Cooper (2008) suggests the first stage of screening should avoid two types of error, these being:

1. NO-GO error – Dismissal of a good idea.
2. GO error – The development of a poor idea.

For example, research by Havener and Thorpe (1994) indicates that an assessment of a product should be thorough and must take into account much more than just the financial gain. They discuss the cases of both the fax machine and Post-it® notes, which would have been rejected if only the cost analysis had been undertaken.

The New Product Development Process

Theory on the introduction of new products concentrates on the development process from innovation to introduction to market (Hutlink and Hart, 1998; Goffin and Micheli, 2010). Concurrent engineering, design methods, technology applications and a range of other techniques that ensure the new product meets the customer requirement. However, new products can still fail in manufacturing terms as they are pushed 'over the wall' (Owens and Davies, 2000) with all the correct documentation, but little or no explanation of what it is intended to be used for. Subsequently, a reoccurring theme within in the literature supports the development of a structured and clear road map of the NPD process can help reduce this failure and the understanding of product newness categories. Figure 1presents a product typology of 'newness' categories. Specifically, product design and development is the interest of this chapter.

New to the World Products.
These new products are the first of their kind and create and 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 and 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 to the company. This product type can account for up to eleven percent of all new product launches.

Figure 1 The Classification of New Products (Cooper, 2005).

'Good design' can be achieved when the product not only looks good, but it also does the job well (Kalyanaram and Krishnan, 1997; Jang *et al*, 2009; Hsu, 2006). Therefore, "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 (Goffin and Micheli, 2010; Holstrom *et al*, 2006; *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"* - a formal NPD process (Cooper, 2005, 2011; Kleinschmit *et al*, 2007). 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

There are numerous examples of previous research (Bhaskaran and Krishnan, 2009; Hsu, 2006; Ogama and Pillar, 2006; Perks *et al*, 2005) where they have attempted to monitor the progress of the new product both prescriptively and descriptively. In addition, some researchers (Danese and Filippini; 2010; Schmidt *et al*, 2009) who are focussing on NPD process models often form dissimilar opinions as to their structure. That said there is agreement amongst researchers in that a generic NPD model cannot be created. However, an agreed commonality is from established research by Saren (1984) are the following 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 specified tasks are 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

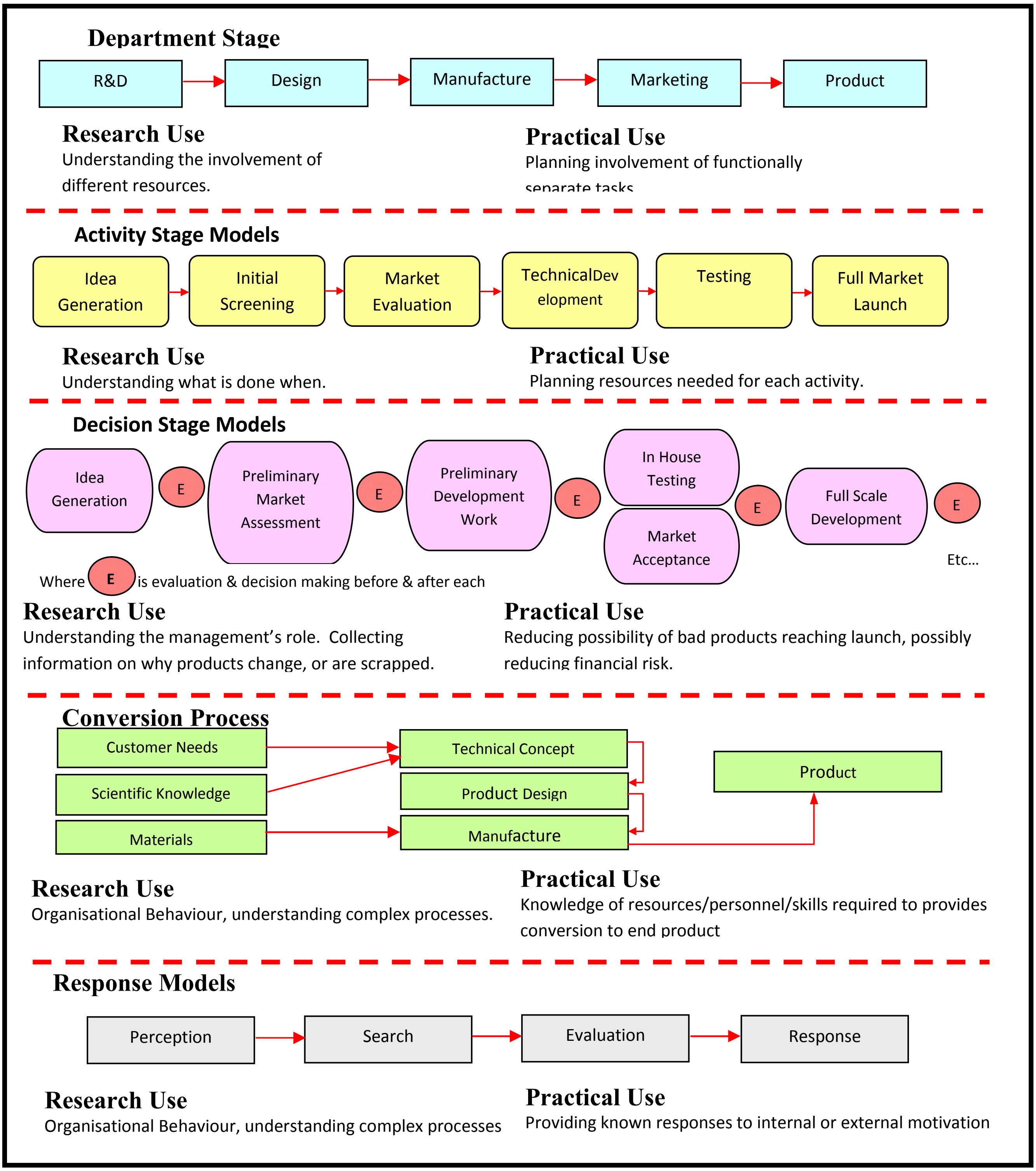

Figure 2 A summary of some NPD process models (Saren, 1984).

on the holistic process of innovation in companies; this is something that is reiterated in more research carried out by Cooper and Kleinschmidt (2007).

More recent research by Noke and Hughes (2010) 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 twenty first century. They (Noke and Hughes, 2010) 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 discuss those that are recurrent in the most recent literature. Subsequently, the remainder of this paper will consider the origins, uses and limitations of five NPD modelling techniques, which are common and progressive:

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 breaks the NPD process into discrete identifiable stages, with each stage being followed by decision gates as illustrated in figure 3. The number of stages can be increased to harmonise with both company and product development requirements. Each stage is designed to gather information required in order to progress the new product onto the next stage of development. In addition, each stage consists of a set of parallel activities undertaken by personnel from different fictional area within the business, but working together as a team. Subsequently, to manage risk via a stage-gate process, the parallel activities within a stage should be designed to gather important information as to drive both technical and businesses uncertainties associated with the new product, thereby facilitating built in feedback loops (Zhao *et al*, 1999; Atilgan-Inan *et al*, 2010). In recent years some researchers (Dayan and Basarir, 2010; Smith, 2011; Troy *et al*, 2008; Fu; 2010) 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 being made by revealing most errors 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 (Petrie, 2008).

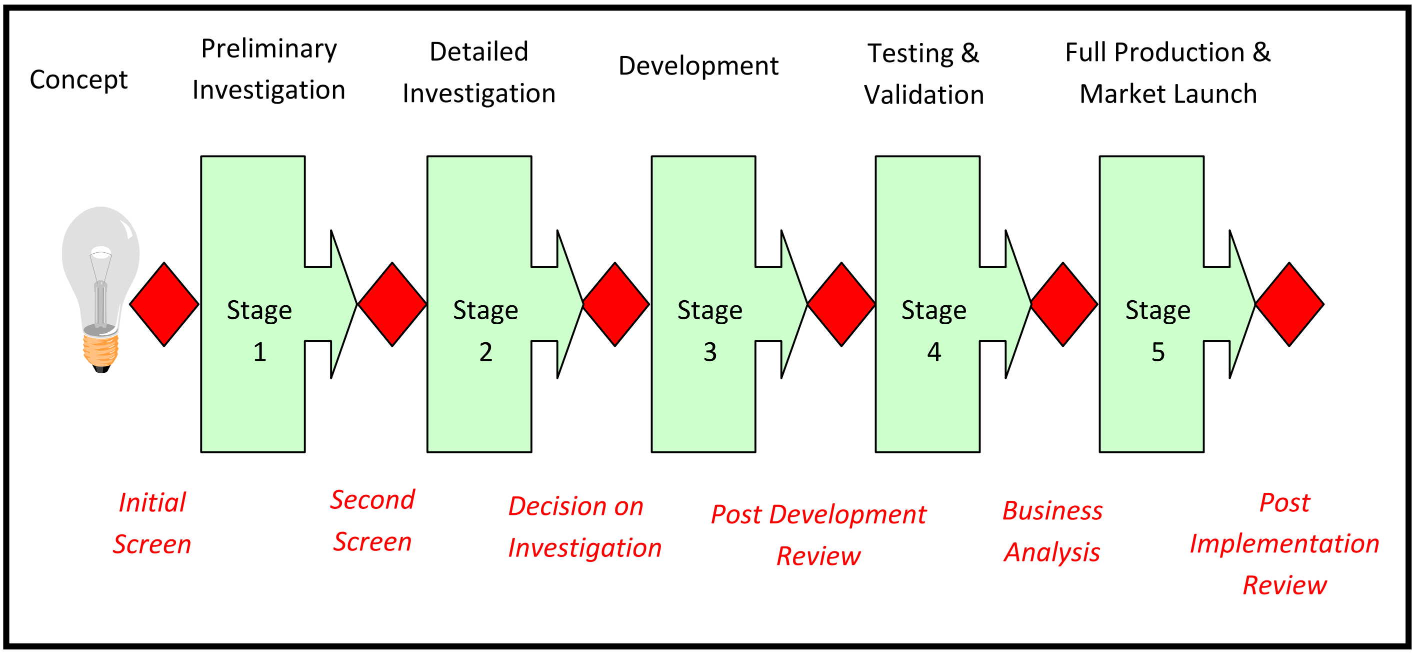

Figure 3 Overview of a Stage-Gate NPD process (Cooper, 2008, 2011).

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 type 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 one that will satisfy the user(s) and ultimate 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, this model can be seen widely in practical use today in some industrial organisations (Cooper, 2008; Owens, 2007, 2009; Smith, 2011) there are some general problems which occur when following a stage gate model which are indicated by Cooper (1999; 2005; 2008). He adds later (Cooper, 2011) that even though the idea has been taken up in the last two decades 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 marketplace needs. It encourages isolation of functional areas and, worst of all, it' very slow.*" It should be noted that these observations do not bode well for the extra and important inclusion of both usability and customer needs compliance in this particular process model.

The Multiple Convergent Model

A key limitation of the stage-gate model and linear NPD process in general is the interaction between the people involved within the process (Griffin, 1997; Shenhar, 2001; Hart *et al,* 2003; Petrie, 2008). One such method that helps address this interaction difficulty is the Multiple Convergent Model. It looks at differing approach to integrate people, both directly and explicitly, into the NPD process, thereby taking into consideration the documented limitations in other NPD process models (Brown, 2008).

The model takes into account the lessons learned that suggest that success comes from having quality inputs which are valid from multidisciplinary areas (Troy *et al*, 2008). There is much importance placed on the use of networks and the production of a model that breaks down multidisciplinary boundaries (Newey and Verreynne, 2011). The models views NPD as tasks with areas moving 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:

- 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) describes 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 (Smith, 2011)

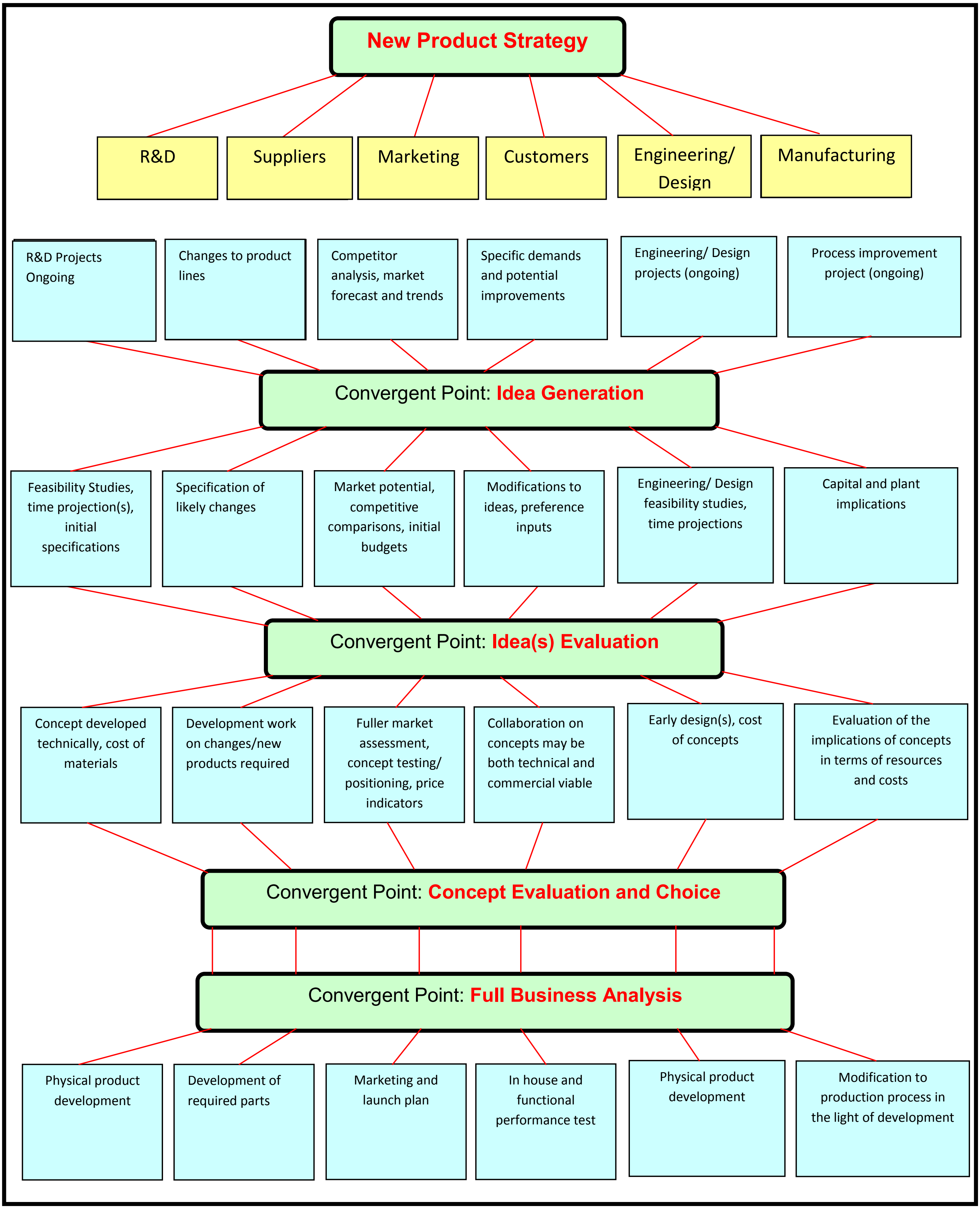

Figure 4 The early stage of the multiple convergent model (Hart and Baker, 1996).

to be conducive with efficiency and it seems to require a large amount of management effort to keep the process on track.

The Product and Cycle-Time Excellence Model

As a supplementary to the multiple convergent model there are alternative modelling approaches whereby the prime focus is to reduce the time-to-market, subsequently, concentrating on how to influence the economic outcome of the design process. The product and cycle-time excellence model McGrath *et al* (1992) is an example of this. It is similar to the stage-gate approach (Petrie, 2008), except that during the phase reviews the decisions are not made by a NPD team involved with developing the new product, but by a small number of senior managers who are the 'Product Approval Committee' (Brown, 2008). 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. Of the seven major elements for this model, four (Jenkins *et al*, 1997) 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 (Akgun *et al*,

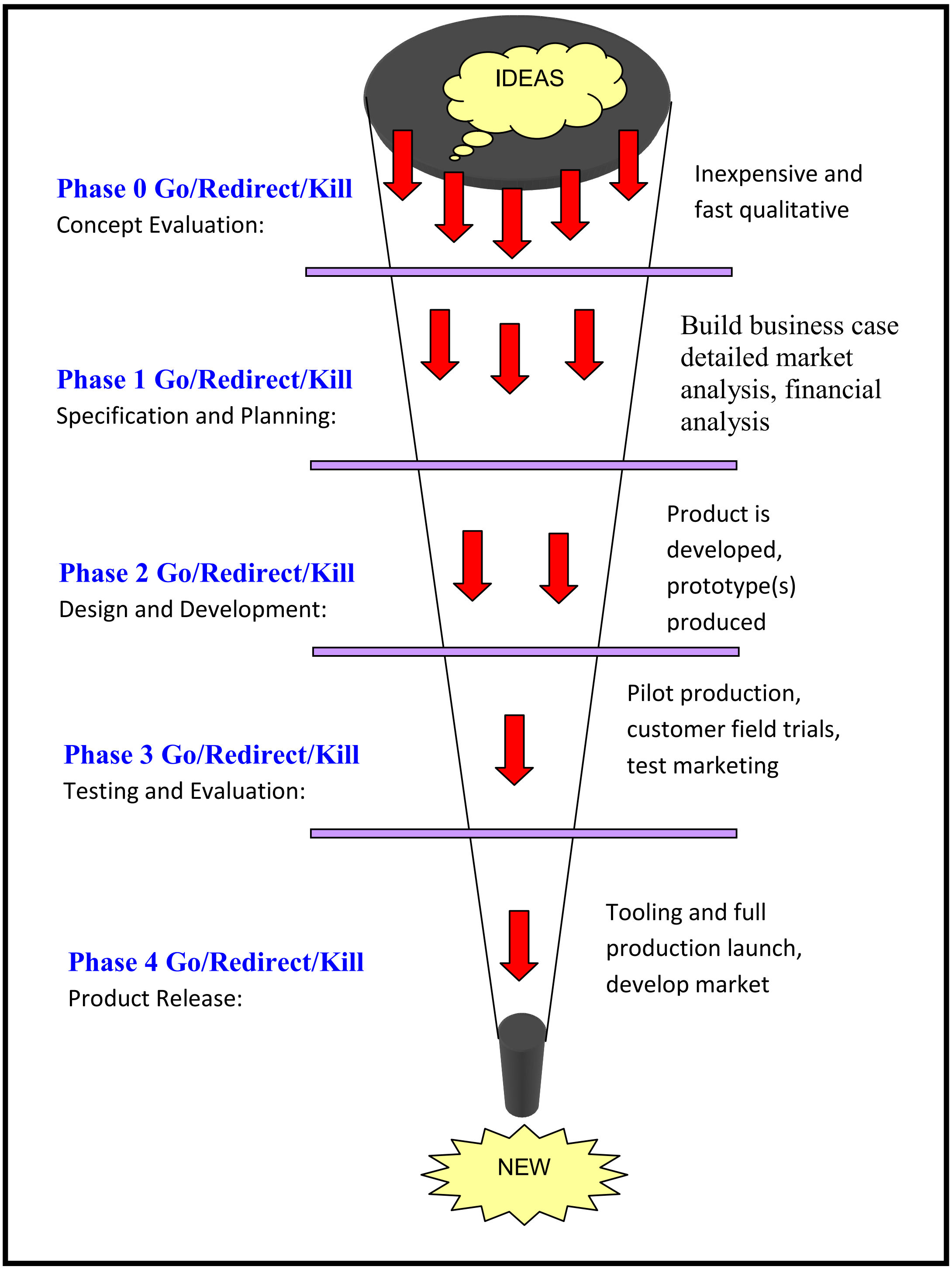

Figure 5 The phase review process within the product and cycle time excellence model (Jenkins *et al*, 1997).

2005; Troy *et al*, 2008). 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 projects, 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 previously in this paper revolve around breaking down the process into manageable portions by seeing the development process as a series of problems to be solved (Brown, 2008; Kleinschmidt *et al*, 2007; MacCormack, 2012). Various authors (Hart *et al*, 2003; Baldwin and Clark, 2000; Griffin, 1997; Moultrie *et al*, 2006; O'Dwyer and Ledwith, 2009; Nicholas *et al*, 2011) 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 of the design process attempts to emulate real-life, in that the design process is evolving (Oakley, 1990). The spiral moves from a formulation 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, which can be cross-sectioned at any point to reveal the interaction between 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 (Brown, 2008; Goffin and Micheli, 2010; Hsu, 2006; Jenkins *et al*, 1997). Also, the total design philosophy is taught as a useful and useable model of best practices on a number of UK higher education institutes'

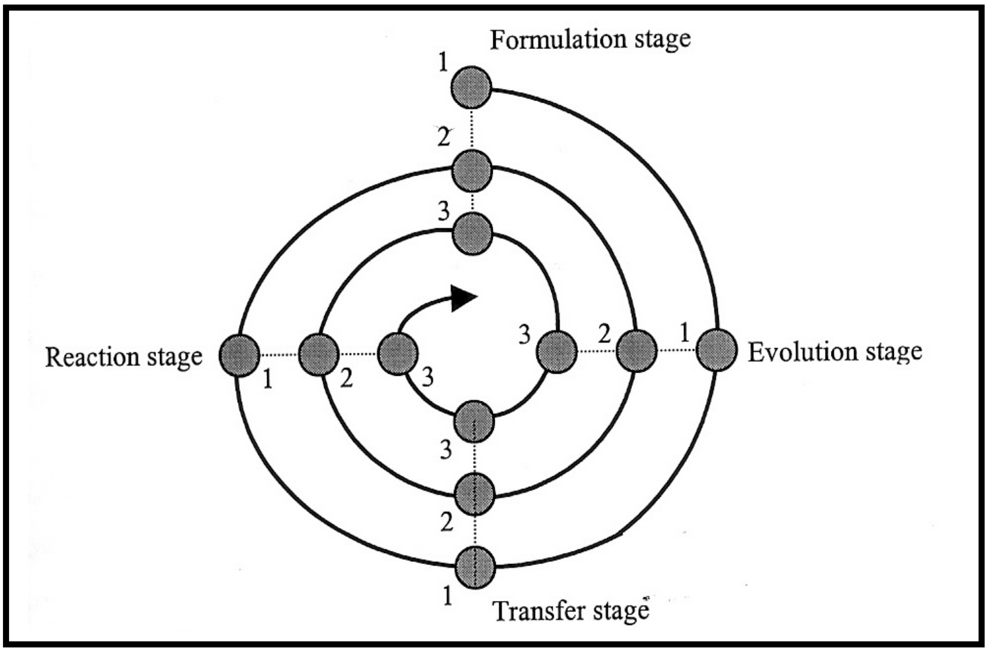

Figure 6 A spiral model of the design process (Oakley, 1990)

engineering courses, especially because it emphasises the use of many different discipline independent tools and methods (Goffin and Micheli, 2010).

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

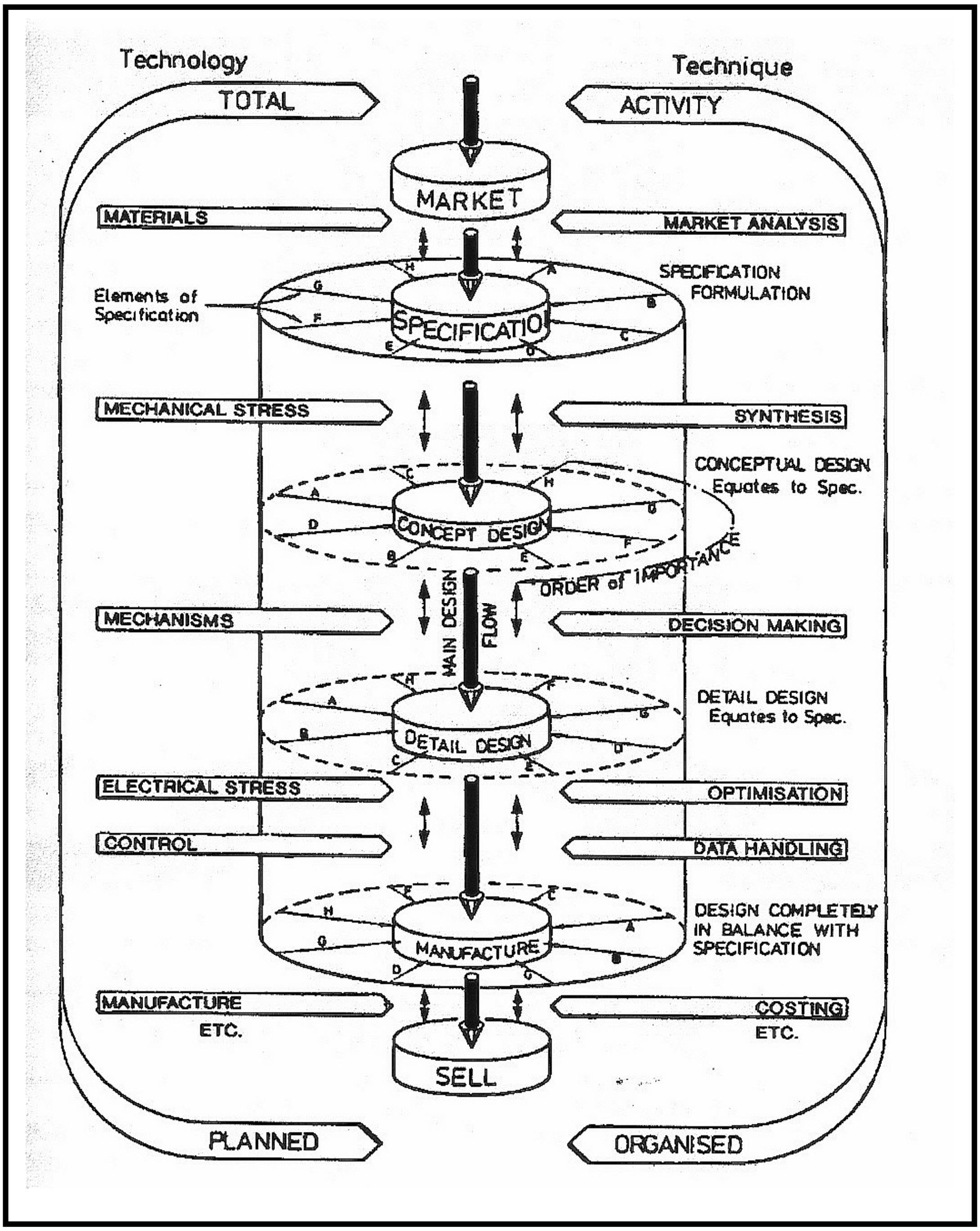

Figure 7 The Total Design Activity Model (Pugh, 1991, p11)

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 disciplinary audience. It also explicitly acknowledges the place of design within the company's structure and long-term strategy (Jang *et* al, 2009; 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 (Carbonell and Rodriguez, 2006). 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 (Brown, 2008).

Requirements Capture Process Model

The requirement capture model developed by Cooper *et al* (1999) captures the understanding of both the individual and the team who are involved in the development of the new product, and how these understandings relate to the customer requirements. This process is illustrated in figure 8. It considers the internal and external variables of the new product comprehension by the parties involved in the NPD process, and how these may influence the data interpretation. Subsequently, the parties involved review the outputs from three levels:

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

It focuses on where there is a collaborative comprehension of customer requirements and needs, in order to produce an agreed outcome and set of requirements. Although established, Cooper *et al* (1998) research is still a useful benchmark in that it provides a focus on dealing with information provided by the customer, in order to establish clear definition by the NPD team as to what the customer requires. Some key issues that are addressed in the model 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)

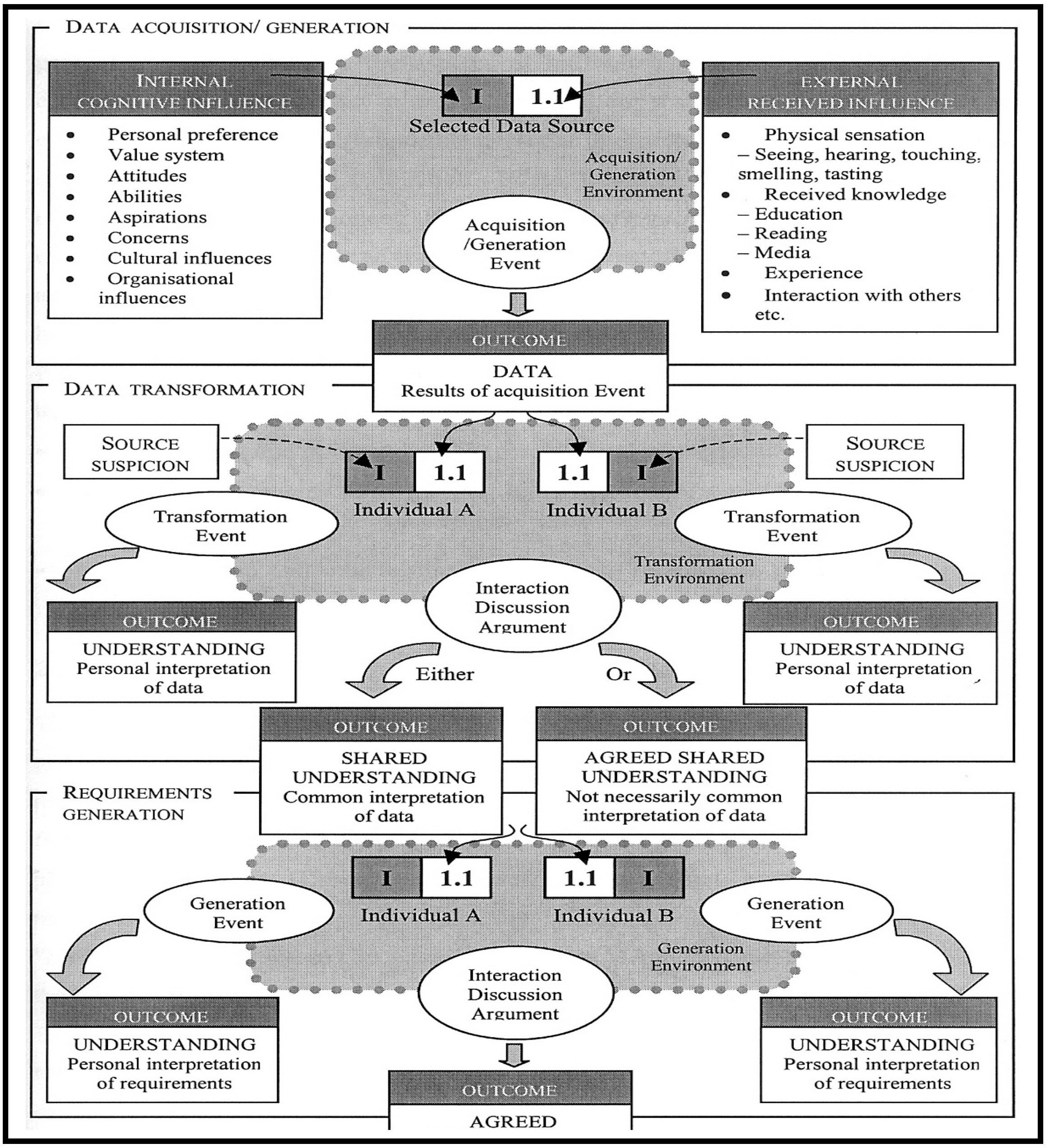

Figure 8 Theoretical requirements capture process model (Cooper *et al*, 1998, p 510).

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; Barozak *et al*, 2009). 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 is finished.

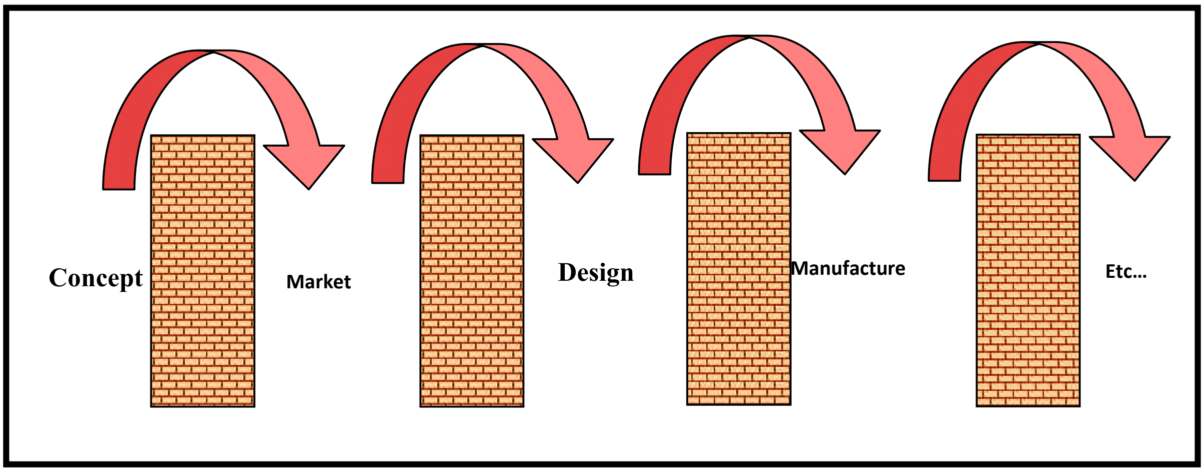

Figure 9 "*Over the wall*" Concept (Owens and Davies, 2000).

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 (Troy *et al*, 2008). According to Cooper (2008) the third generation are the future way in which products should be produced. He suggests these third generation processes are relatively ill 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 (Carbonell and Rodriguez, 2006; Chan, 2010).

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 of a preceding activity, as illustrated 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 (Ogama and Pillar, 2006; Reid and Brentani, 2004). It will allegedly work from a premise that attempts to maintain discipline, but allows a balance of

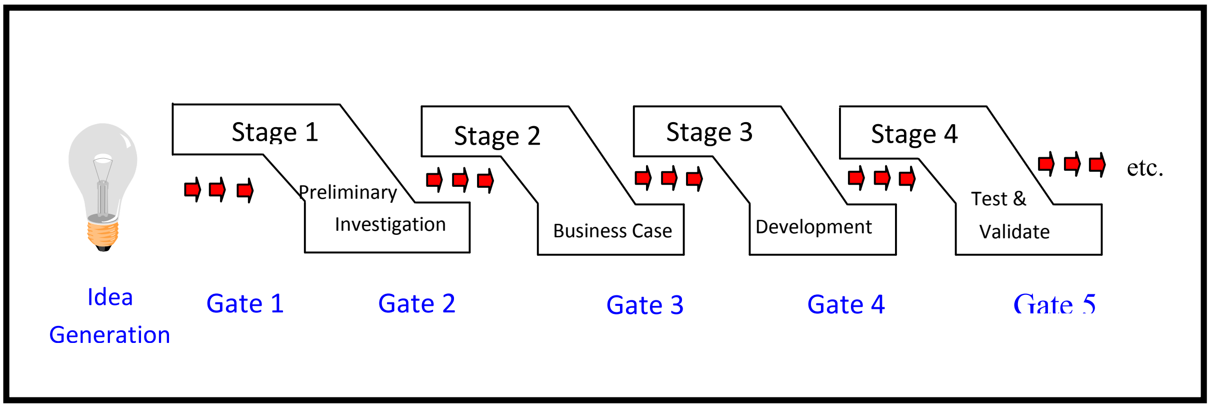

Figure 10 Third Generation Process (Cooper, 2011).

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, 2011):

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 dependent 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. Later Cooper (2005) 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 should 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 (Jorgensen and Messner, 2009; Rodriguez *et al*, 2008).

Summary: The usefulness of a NPD process modelling approach

The previous commentaries show the immense profusion and disparity as to the different approached to modelling the NPD process. This is by no means a definitive discussion, but rather a reflection to direct the reader to the vast multiplicity that exists in this field. The need to observe and comprehend the differing modelling approaches, and how one might portray the NPD process is that of practicality. For example, if one can somehow capture what a business does, and can realise the path the product development process takes, then perhaps it may be possible to have an improved and useful comprehension of how to enhance and improve the NPD process, then it may be possible to secure tangible benefits. Past research has suggested that positive consequences result from the existence of formal NPD processes. Also, research (Cooper, 2011; Moultrie *et al*, 2006; Petrie, 2008; 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 and minimising differences between companies and products (Noke and Radnor, 2004; Johnsen, 2011). 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 phenomena 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; Jorgensen and Messner, 2009).

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 table 1. 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 are being investigated in this research to be able to understand at least some of the facets of customer needs compliance during the product development process.

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.

Table 1 Model of the need assessment process (Holt *et al*, 1984).

Considerations for Further Research

In summary, it is perhaps apparent various researchers have provided a lot of different methods for depicting the NPD process. Although, one important finding is so far none of the methods have been specifically developed for the following customers' needs through the NPD process from concept to launch. However, the representation of the linkages within NPD practice that these models demonstrate is perhaps a useful starting point for further examination, as long as they are taken within their context and understanding of their limitations. Therefore, in order to advance this research, a review of the literature incorporating management and information provision for customer needs compliance issues, in order to ascertain of there is a correlation with the earlier comment.

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