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Can The Development Of A Conceptual Model For UK Engineering Companies Help Understand What The Customer Wants From New Products?

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Abstract—The long-term survival of a business often hinges upon its ability to successfully introduce new products into the market place. These new products and their successful development can be the lifeblood of a company. Thus, New Product Development (NPD) is a major consideration for most organisations. New products can provide the stimulus for the company to grow and produce profitable returns. Additionally, new products can gain new markets and market shares and subsequently help to defend against competitive pressures. Some businesses not only want to accelerate their NPD efforts, they also like to be a ‘first to market’ business. However, this strategy has its own risks as well as competitive advantages. There are numerous cases where businesses first to launch a new product did not profit from their innovations as much as their followers. Therefore, across numerous businesses NPD is one of the leading areas for focus, as companies seek to reduce time to market, access new technologies and develop more and better products. Subsequently, the consistent development and introduction of new products that customers’ value can be an important criteria for business growth and prosperity. There has been much research into defining the NPD process and the management of its activities, and this was useful as an opening for this research. However, there is little evidence that details the specific aspect of designing for customer needs compliance. This research is exploratory in nature and provides empirical support to several propositions found in the literature on the development of new products to meet customers’ needs compliance. The findings suggest that each of the companies do perceive a difference in the needs of the customers between different product types. However, they also imply that specific types of customers have similar needs, no matter what types of products are involved.

Keywords—New Products, New Product Development, Customer Needs Compliance

Introduction

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 (Bhaskaran and

Krishnan, 2009; Cooper, 1999; Griffin and Houser, 1996; Kaipia and Holmstrom, 2007; Smith, 2011).

Therefore, in providing these new products New Product Development (NPD) is a major issue for most companies (Bessant *et al*, 2003; Cooper, 2011; Cooper *et al*, 2004a; Olson, et al 2001; Owens, 2007). Across both manufacturing and service sectors, it is a leading area of focus as companies all seek to reduce time to market, reduce the development cycle, access new technologies and develop more and better products and services (Owens, 2004b; Taylor, 2010). 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 (Albright and Kappel, 2003; Smith, 2011). It is therefore a subject, which has received and continues to receive much attention, particularly in seeking to improve its effectiveness and efficiency.

Many authors (Akgun *et al*, 2005; Cooper, 2011; Bessant and Caffyn, 1997; Kleinschmidt *et al*, 2007; Nonaka, 1991; Schmidt *et al*, 2009; Wagner and Hoegl, 2006) have empirically explored and discussed in detail the key factors that separate successful product development from failures. However, there are still many projects developing new products that fail (Barczak *et al*, 2009), because

they do not meet the customer requirements, are over budget, are not of the perceived quality within the development process and for many other legitimate reasons. Why does this still happen? One possibility could be that innovation can be seen as a task of cross-functional information and decision-making within a complex development environment (Troy *et al*, 2009). Understanding what will be successful in the marketplace and developing a new product for your customer is consequently a culmination of appropriately abstracting, transforming and transferring data, information, knowledge and skills.

Research Stimulus and Key Terms

This research was stimulated by an interest in the process which multidisciplinary NPD teams use to try and ensure their products meet the needs of the customer.

This research is concerned with issues surrounding customer-based needs and optimum product design. Table 1 provides an epigrammatic explanation of the key terms associated with this research.

NPD and its Management.	Management support throughout the NPD process is a necessary ingredient for product innovation. Consistently research suggests (Cooper, 2011; Griffin; 1997a; Hart, 1989; Harborne and Johne, 2003; Wheelwright and Clark, 1992) that effective NPD management is directly linked to innovation and desired product success, by the customer. Subsequently, this research will focus on managing techniques involved during the NPD process.
Quality.	The phrase “a <i>quality product</i> ” suggests (Cooper, 2008; Havener and Thorpe, 1994; Kohn, 2006; Kuczmariski, 2003; Sun <i>et al</i> , 2009) an excellence or goodness that has been bestowed upon the customer. However, in the terms of this research quality should be taken as “customer needs compliance and satisfaction by the product characteristics.”
Customer Needs Compliance.	The customer is anyone who is involved with the product (and/or service), or influences the buying decision either directly or indirectly (Kotler and Keller, 2012). During the innovation process it is a key necessity to comprehend what the customer needs are, and thereby provide a means of delivering them, thus complying with their desires/requirements for the product(s).

Information Transfer during Product Design.	Information and knowledge to capture customer requirements can have differing internal and external influences upon the designer during NPD (Moultrie <i>et al</i> , 2006). Thus, when the product development commences, customer needs are going to be generated from difference sources (Kleinshmidt <i>et al</i> , 2007; Petrie, 2008). Different individuals may see the market, customer and product requirements differently because of the way each transform, interpret and view the same customer related information (Nicholas <i>et al</i> , 2011).
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Table 1. Epigrammatic explanation of the key terms associated with this research.

Research Focus

The research is based upon an investigation of possible variables that might affect the success of

NPD in a small selection of UK Engineering Small to Medium Enterprises (SME’s) using Total Quality Management (TQM) and they were developing new products within a Business-to-Business (B2B) market environment, with the objectives of understanding more fully the implications of designing for customer needs compliance. The research also aims to understand the perceptions that the design team have of the product in terms of customer needs. It is also an aim to determine how customer needs compliance activities and information transfer during NPD could affect the final design and, consequently, the quality of the product.

Therefore, the general research question addressed was:

“How do engineering companies currently define what the customer wants from the development of new products and if the development of a conceptual model could aid the identification of what is the role of information management and customer needs compliance during NPD?”

The direction of this paper will discuss and clarify how this preliminary empirical research will be undertaken in an attempt to provide an explanation to this question. It takes qualitative ideas that are difficult to evaluate and breaks them down into terms that can be evaluated as constructs in the conceptual model for customer needs compliance.

Quality - The ability to satisfy stated or implied needs.

Many companies use the phrase “a quality product”, indicating an excellence or goodness, which

they have bestowed upon the item (Cooper, 2008; Havener and Thorpe, 1994; Kohn, 2006; Kuczumski, 2003; Sun *et al*, 2009). However, the origin of this word is actually not biased positively. White (1996, p12) recalls that it comes from the Latin *qualitas*, which “seems to be a neutral description of an object, where use of adjectives like good, bad etc. make no sense. In other words, quality originally had an objective content, connected to the product itself, as the object really is.”

Quality is in general deemed to be a subjective issue, it is in the perception of the beholder, otherwise everyone would seek out exactly the same “quality” items that, often, they do not (Kuczumski, 2003). Indeed, superior engineering product design and development pays attention to the right quality of the product, satisfying the right customer targets (Buskirk *et al*, 2009; Millward and Lewis, 2005; Rahim and Baksh, 2003). Cooper and Kleinschmidt (2004a, 2004b, 2004c, 2007) found this product advantage in the market place to be the most important factor for a successful design. This is also empathised in the definition used by the International Standards Organisation (ISO):

“quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.” (Rothery, 1993, p31, quoting ISO 8402)

Thus, since the word ‘quality’ can be misconstrued, this research attempts to distinguish the context of the use of the word throughout this paper. Therefore, wherever the word quality appears it should be taken to mean “customer needs compliance and satisfaction by the product characteristics”.

Defining and understanding the customer

Product quality is therefore determined by the customer of the product, whether they be retailer, buyers, installer, end user maintainer etc. Yet companies produce and sell products using the word ‘quality’ as though it only has to do with how much the buyer will pay for the features that affect the main user (Evans and Lindsay, 2011; Prabhu *et al*, 1999). It is perhaps not surprising that, although engineering design companies in the industrial sector recognise there are many people involved with the product, however they often fail to consider all of the potential customers during the development of their products (Moultrie *et al*, 2007; Pugh, 1991).

The customer is anyone who is involved with the product (and/or service), or influences the buying decision either directly or indirectly (Kotler and Keller, 2012). White (1996) indicates the ‘user’ and the ‘customer’ are synonymous because they have to buy into an idea and invest themselves in the product. However, this seems lacking in detail, especially for

industrial products, where the end user may not have a direct influence over the purchase at all (Mazur, 2003). Some authors (Jobber, 2009; Kotler and Keller, 2012) discuss the industrial customer as a Decision Making Unit (DMU) comprising of six main roles, including buyers and users. These roles have their origins in research conducted into buyer behaviour in the seventies and eighties (Webster and Wind, 1973; Johnston and Bonoma, 1981). Although these descriptions may be changed to suit the organisation, the roles of the installer, maintainer and disposer are only hinted at in the role of the influencer and not explicitly addressed. Owen and Hills (1996) identifies seven main stakeholders who are customers for the whole life of the product, which include maintenance, service and disposal, but do not recognise roles such as influencers and initiators that are included in the classic DMU. Hill (1972) presents another view of the customer for industrial products. He identifies a number of separate, smaller, functional units which are the basis of the product buying group, but this analysis, by its nature, does not entirely satisfy the differing customer roles which interact with the product during its life.

As can be seen from this initial discussion, the role of customer can be somewhat subjective and subsequently can mean different things to many people. However, in terms of this research the focus will be as identified in table 1 as “*The customer is anyone who is involved with the product (and/or service), or influences the buying decision either directly or indirectly*” (Kotler and Keller, 2012).

How can the design process allow for customer needs?

The ISO definition of quality indicates a role for the NPD process. It suggests that, to ensure they are developing a product that will satisfy the customer, designers have to include features and functionality in the product that will yield the required benefits. The design should meet the needs, expectations and values of the customer (whoever they are), so the product is fit for the customers’ purpose. Therefore, of prime importance during innovation, is the provision of the information which will help developers know what the customer needs are and provide a means of delivering them as a product which is unique and superior in the eyes of the customer.

NPD is carried out by companies following some sort of path, route or process that incorporates activities over a period of time to provide an output – the product. The activities undertaken during the development can affect the outcome of the project and how this outcome is determined a success or failure (Cooper, 1999, 2005). A single, workable, generic process for NPD cannot be easily defined due to the dependence upon so many subjective variables (Barczak *et al*, 2009; Cooper, 1999, 2011; Gary and

Maybe, 2005; Hart, 1996; Wheelwright and Clark, 1992).

During early development, requirements are decided and priorities set for the further detailed design and build of a product. It is often during these front-end preparatory steps that decisions are taken that define the product and determine whether it will incorporate an ethos of design for the customer needs, either implicitly or explicitly (Krieg, 2004). Information is important in generating and developing concepts that are orientated towards the customer. Building up a strong competence in the capture of information will, therefore, affect the competitive performance of the company (Bruce *et al*, 1996). It has been found (Griffin and Houser, 1996; Cooper, 2011) that information collected in a form that is both understandable and usable by the design team, which is then communicated clearly and effectively is very important to the marketplace success of the product. The methods used for this communication has been the subject of numerous previous research studies by management, marketing and engineering design researchers. Of particular interest to the direction of this research, is the lack of empirical research regarding the whole development process and the communication of information that may affect customer needs and their compliance for the design process.

Method

This research is concerned with the “what”, “why” and “how” subjects related to these areas. Both Yin (2009) and Robson (2011) recommended for research projects of this nature focussing on the “what”, “why” and “how” questions, the case study approach is preferred. This research is dedicated on acquiring evidence, identifying the current practices during the NPD process for each case company involved in this research. Gummesson (2007) suggests that, while qualitative research is concerned with issues such as how much, how often and how many, qualitative research on the other hand is concerned with identifying certain phenomena based on an in-depth exhaustive investigation and analysis. While according to Johnson *et al*, 2007 researchers adopting a qualitative perspective are more concerned in understanding individuals’ perceptions of the world, rather than statistical analysis. One advantage with case study research (as with survey research) is that it enables comprehensive and informative data to be generated (McBurney and White, 2012).

The companies involved were asked about what they thought were the most important attributes during the NPD process and ultimately achieving the end product. On initial investigation, the views of what are important are quite different, even within the same function. However, there does appear to be a tentative link between the job position held and the

views given, i.e. those at the ‘bottom’ (often the ones doing the detailed design) have similar views to one another, but opposing views to those higher up in the chain of command. This is perhaps an important early methodological observation, because further investigation beyond this preliminary investigation may find more prominent groupings other than function.

The developments of new products follow similar paths. Each project is set up and a team appointed to produce project work before full-scale product development. The team provided information on requirements, time scales, costs, sourcing of materials and development labour, together with supply and warehousing issues. A senior engineer/manager takes control of the project and has a multidisciplinary team working for them. Project timings ranged from two months (approximately) for product customisations to two or three years (upwards) for development of a whole product range. The teams are put together for this amount of time and then disbanded. Also, most of the team are part-time members, working on a number of different projects at any one time. All of those interviewed were part of a NPD team, but had very different backgrounds and different knowledge of the customer. This is typical of current NPD practice and perhaps supports (Nicholas *et al*, 2011; Wright 1998) the need to understand the discipline or functional background of those involved in the NPD team.

Developing a Framework of Product Quality

Fundamental to the development of a conceptual framework is how the artefact and its associated quality are viewed. The satisfaction of the customer (overall quality of the actual product) is determined by the customer (Drucker, 1968). Hence, the quality of the product, the actual product offering itself, and the customer needs can be considered as three separate entities that are inter-related. Thus, ‘Product Quality’ is a synonym of customer needs/requirements of the end product. It is a comparison of how well the customer needs are met by the product, thus the products alone possesses no specific quality, rather a combination of quality attributes ready to be assessed by potential customers, who determine for themselves the overall quality of the product (Ho *et al*, 2005). This interpretation relates positively to the ISO8402 definition, which establishes quality as the ability of a product, in totality, to satisfy the needs of the customer (Chong, 1999). Figure 1 illustrates the relationship between product quality, the artefact and customer needs.

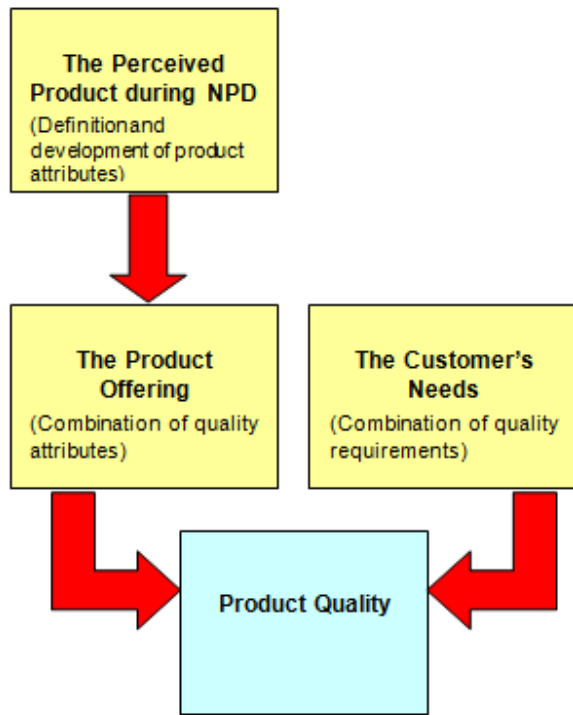


Figure 1 A Framework of a Product's Quality

In addition, it considers how the product might be viewed during its development. Just as different customers will have different perceptions of the product and the quality attributes they require, so too will those who are involved in the development of the products (Mazur, 2003; Perks *et al*, 2005). As the design evolves, many different people drive the development, whether they are marketers, designers, researchers, managers, ergonomists, industrial designers or production experts (Kleinschmidt *et al*, 2007). The way the product should look, what it should do, how it should do it, who will want it and why, are all perceptions of those who will shape and form it into its final incarnation (Barczak *et al* 2009). Thus, the product requirements and the expected artefact itself may change and evolve before the completion of the development process (Schilling and Hill, 1998). This is demonstrated by showing the actual product that is offered to the customer as being the outcome of (and being possibly different to) that which is perceived as the product during its development. This simple framework illustrates that the product is only perceived by the development team until it becomes a reality.

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A Model of NPD and Customer Needs Compliance

A conceptual framework explains the main things to be studied; be they events, settings, processes or theoretical constructs (Maxwell, 2012b; Miles and Huberman, 1994). Presented here is a conceptual model that shows possible relationships between variables which may affect customer needs compliance (product quality). The development of the conceptual model in figure 2 has been achieved by developing three key areas, which are considered to be of primary importance to this research and ultimately customer needs compliance:

1. The roles that perceptions play.
2. The provision of customer data and information to the company.
3. Company Influences upon Customer Needs Compliance.

The Role of Perceptions

The perceptions of the groups of individuals involved during NPD may have consequences for the product's outcome (Akgun *et al*, 2005). A consistent theme within the research (Akgun and Lynn, 2002a; Fang, 2008; Gentile *et al*, 2007; Johnsen and Ford, 2007; Kasabov and Warlow, 2010b; Mascarenhas *et al*, 2004; Sethi, 2000) is the lack of synergy between a team's perception of the customers' needs and the reality of those customers' needs may be detrimental to product development. For example, it may mean that even if a company has large resources, they could be directed or used unwisely, thus concentrating on aspects that need little attention, rather than providing important competitive advantages (Dayan and Basarir, 2010). Therefore, company perceptions are included in the conceptual model (figure 2).

Over time numerous researchers (Bonoma *et al*, 1977; Bacon *et al*, 1994; Berente *et al*, 2010; Cooper *et al*, 1998; Cooper, 2011; Creusen and Schoormans, 2005; Hakansson, 1981; Kasabov and Warlow, 2010b; Mascarenhas *et al*, 2004) claim it can be expected that each individual in the company will have their own perceptions. Through discussions and interaction with other members of a particular group, these perceptions may merge to form a group perception. The groups may be those of nominal functions within the company (i.e. marketing, sales or R&D) or they may be management groups or grouped by the level of interaction with the customer (Joshi and Sharma, 2004).

The Provision of Customer Data and Information

Previous studies (Cooper and Kleinschmidt, 2000; Goffin and Micheli, 2010; Hart, 1996; Holstrom *et al*, 2006; Wheelwright and Clark, 1992) have discussed

how the lack of information or inappropriate information can affect the success of the product in the marketplace. Thus, the provision of data and information to the development process is included in the conceptual model illustrated in figure 2. The provision of data and information fits into the conceptual model of customer needs compliance in the NPD process as two sets of activities. One set involving the gathering of data and information, the other about its transfer. The conceptual model has the same inference in that the information gathering and transfer activities are indirectly linked to the definition of product needs via the interpretation and application of the NPD groups.

Company influences upon customer needs compliance.

There many other aspects that may affect the NPD process and the ability to comply with the needs of customers (Kasabov and Warlow, 2010b). For example, management skills and orientation, NPD strategies, company infrastructure etc. These issues were recognised in the conceptual model as affecting the definition of the needs for the product and throughout the whole design and development process. For example, one company believed their company fared poorly against the competition; this attribute was never taken in isolation and was weighed against other attributes. Therefore, as research suggests (Barczak *et al*, 2009; Cooper, 2011) their complacency in the market place and NPD strategy may have a negative effect on meeting the customer needs, and potentially the medium to long term survival of the company itself.

Main Construct	Meaning	New Constructs to be defined
Product Quality	How well a product meets the needs of the target customers?	Abstract product, abstract needs, abstract target customer.

But abstract quality cannot be measured, therefore it is taken that there are four forms which product quality takes in reality because of **the role of perceptions**.

Customer perception of product quality	How well a product offering is perceived by the customer to fit into the competitive situation by meeting the customer's needs.	Product offering, customer competitive situation, customer's needs, customer.
Group perception of product quality	How well a product offering is perceived by the group to fit into the competitive situation by meeting the particular market needs.	Product offering, group, competitive situation, market needs.
Product needs definition for product quality.	The consensus on group perception of product quality.	Group perception of product quality.
Product design priorities set during NPD.	The consensus as it changes during the NPD process.	None

Important for this study are the activities of the NPD process which affect the perceptions of product quality, in particular **the provision of customer data and information to the company**.

Customer information management	The management of customer data and information collection and transfer processes.	Customer data and information collection process, customer data and information transfer process.
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Aspects which may affect product quality, but can only be included in the study as controlled confounding variables are **other internal company influences**.

Internal company influences	Other company influences that may affect the NPD process.	None
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Each of the new constructs introduced above require a conceptual definition:

Customer	Some customer type who is involved with the product offering.	Customer type, product offering.
Customer type	Who is the customer? How important are they?	None
Product offering	Defined by product variables.	None
Competitive situation	How does a product offering compare with other offerings in the marketplace?	Product offering.
Customer's needs	Importance given to particular product attributes by the customer.	Product attributes.
Product attributes	Separate definable product characteristics.	None
Group	Type of group affiliation e.g. functional involvement, or management group.	None
Market needs.	What the customer's needs are for the particular customer in a type of market?	Customer's needs, customer, type of market.
Type of market.	Mass or niche products.	None.
Customer data and information collection process.	What information is collected on product attributes, how and when?	Product attributes.
Customer data and information transfer process.	What information is transferred on product attributes, how and when?	Product attributes

Table 2 Conceptual definitions of constructs.

The conceptual model is the focus of this research and offers an approach to identify issues of compliance during the NPD process. A significant limitation of this model is that only issue of compliance are identified, and as such no 'solutions' are provided. However, as almost (Owens, 2007) every NPD process can be different (diminutive or significant) and thus a prescriptive resolution may not be appropriate.

Conceptual Definitions

Having discussed the basis for the conceptual framework, it still remains to develop narratives of how the theoretical relationships it presents can be measured. The first step in doing this is to provide

constitutional or conceptual definitions (Smith, 2002). According to Tull and Hawkins (1993, p300) a concept or construct is an "invented name for a property of an object, person, state or event." Therefore, the conceptual definition conveys the central idea of a construct by defining it in terms of other constructs that are known.

Theorising and empirical exploratory research has helped evolve the three key areas identified earlier into the conceptual model illustrated in figure 2. However, producing a conceptual model is incremental and is very often shaped by the research agenda (Amaratunga *et al*, 2002; Robson, 2011). Also, some of the constructs included in the model are parts of higher-level constructs. Therefore, some explanation of how the eventual conceptual model was produced; through the use of the three main areas listed above; is also included in table 2. It also lists intermediary constructs as well as those constructs that are included in the conceptual model illustrated in figure 2.

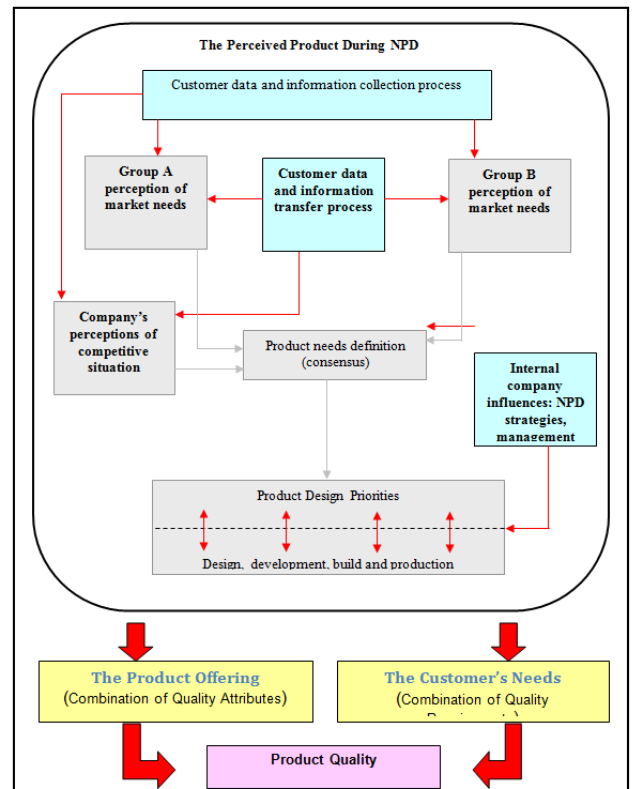


Figure 2 A Model of NPD and Customer Needs Compliance

Discussion and Limitations

The development of the model of NPD and Customer Needs Compliance illustrated in figure 2 was achieved after an exploration of the main fields to be studied through the development of a framework of a product's quality illustrated in figure 1. In addition, the development of the model of NPD and

Customer Needs Compliance was achieved by developing and building upon the three key areas.

It was evident (Akgun and Lynn, 2002a; Fang, 2008; Gentile *et al* 2007; Kasabov and Warlow, 2010a) early in the research **the roles that perceptions play** that because of the lack of synergy between a team's perception of the customers' needs, and the reality of those customers' needs, may be detrimental to product development. For example, one company did not put a great deal of effort in maintaining company brand images, as it was almost taken for granted. Subsequently, this was an important finding for this company in future use of their brand image in their NPD.

Previous research (Hart, 1996; Cooper and Kleinschmidt, 2000; Goffin and Micheli, 2010) have discussed how the lack of **provision of customer data and information to the company** can affect the success of the product in the market place. The provision of data and information fits into the conceptual model of customer needs compliance in the NPD process as two sets of activities:

1. The gathering of data and information
2. The transfer of this data and information.

For example, a customer for one company got the impression customisation was not particularly an important feature. However, the company believed this was one of their prime strengths, and spent considerable time and effort in maintaining this in order to be superior to the competition.

Focus for Further Research

The results from the model are only applicable to the companies involved within this preliminary exploratory investigation. However, the framework of a product's quality and model of NPD and customer needs compliance could have the potential to be generic to cases operating within a similar domain. As research indicates (Bhaskaran and Krishnan, 2009; Cooper, 2011; MacCormack *et al*, 2012) companies that are introducing new products on a regular basis, can use existing NPD techniques to assist them. Therefore, in the first instance further research is necessary to evaluate if using the data collection protocol and application of the framework and model to other similar small to medium size UK engineering companies could provide similar outcomes.

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