

Design processes for OBM firms in the NPD process

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For production-oriented companies such as original brand manufacturers (OBMs), management of the NPD cycle is essential to how their business functions. However, because these companies focus on R&D activities, engineering and manufacturing goods, they often see design as a small fragment of their product development cycle rather than as an integral part of the process. This paper investigates current design processes, identifying how each process is run by different businesses. Literature reviews and in-depth interviews are undertaken with key NPD project personnel from OBM firms and international brands, to evaluate firms' current problems operating the existing processes. The findings show an overview of how the design process is carried out by various functional groups in OBM consumer electronics companies and international brands respectively. It is anticipated that contributions to this research will guide OBM firms' activities in each process of design, and help to improve managing overall design practices.

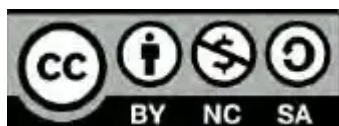
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Introduction

Designers and non-designers in any organisation each have their own approach to the challenges faced by a company, and both have a particular set of skills, influences and responsibilities which affect how they approach design problem-solving. These differences influence the processes and methods which each party employs to approach the development of new products and services. For production-oriented companies, managers overseeing the development process are often primarily concerned with the elimination of defects and controlling production quality, rather than questioning what the most appropriate design should be. Each phase is therefore executed in the most straightforward, logical, cost-effective and least time-consuming way. As a result, these production-oriented firms do not take full advantage of design, and truncate their product development cycles by minimising the design process, which tends to make it less rigorous.

This research investigates the existing design processes during new product development (NPD) in academia, professional organisations, international companies and OBM electronics firms. A design process can be perceived as a generic procedure to create a design, or as a sequence of activities and disciplines which occur while performing a design task (Clarkson and Eckert eds., 2010). In this research context, the perspective on the design process will be focused on the activities of each process of design and disciplines engaged in the design process. Design processes have been discussed by academics as the broader procedure of design or structure and graphical notation of the process, rather than focusing on providing insights into specific stages or activities at the practical level (Bobbe, Krzywinski, and Woelfel, 2016). It is therefore important to examine current processes to identify how each process is operated by companies which have different business backgrounds or levels of experience in design.

The existing design processes developed by academia have allowed professional organisations to efficiently and strategically follow the design procedure (Clarkson and Eckert eds., 2010). However, some researchers have shown that OBM firms continue to resist adopting design as a strategic tool and an effective process which allows the firms to achieve design goals ranging from problem definition, research, the understanding of customers and markets, ideas generation, design, prototyping, and evaluation to implementation (Brown,



2008; Hsu, 2009; Guo, 2010; Yan, Chiang & Chien, 2014). Other studies identified that those firms' lack experience in design and internal resources to support executing design implementation could be a major factor which bring challenges and causes NPD project failure (Lewis & Brown, 1999; Anon, 2005; Berends, Reymen, Stultiëns & Peutz, 2011). Hobday (1995) and Wong (1999) note that only a few exceptional OEM firms have managed to transform into an OBM system, while the rest have struggled to generate new product innovations, build brand values or establish their own distribution channels (Kim and Nelson, 2000; Yan et al., 2014). To effectively move upstream to OBM design becomes an increasingly relevant factor, by consistently pursuing quality and continuously generating differentiating factors for the technologies, products, and branding (Tsai & Hung 2006; Lee, Kwak & Song, 2011). Since the role of design may result in new business practice, it would be beneficial to explore new approaches to performing design activities more efficiently and effectively in OBM firms. This study evaluates current design processes in OBM consumer electronics companies and seeks effective steps for companies working with external design agencies.

To obtain a realistic view, in-depth interviews have been undertaken with key NPD project personnel from international brands and OBM consumer electronic firms and their current problems in operating the existing processes have been explored. It evaluates the suitability of existing design process models and examines whether their unfamiliarity of the (design process) models makes it harder for OBM firms to use those models adeptly during the NPD process. The paper also discusses cooperation between external design experts and OBM firms while considering their ability to manage the increasing complexity of design problems and the more practical level of the design process which can help an organization implement a design effectively and efficiently.

The importance of the study becomes evident when OBM consumer electronic companies are able to avoid common design problems during NPD. The study focuses on investigating the actual conditions of NPD design processes, examining how the design process can be more practical for OBM companies to use so that they can successfully achieve their goals. It is expected that this research will contribute to guiding both OBM firms and external design agencies to the generic procedure of design activities, to help improve overall design outcomes. The study aims to help OBM firms improve speed and efficiency, and reduce design management risks during the NPD process.

Only a limited number of in-depth interview researches has been completed on how OBM firms manage a design process which is integrated with their former product development process. Previous researchers have identified that it takes time for an OBM firm to make design integral to the organisation and that it may face challenges when inviting external professionals to develop design (Anon, 2005; Bolton, 2009; Lee, 2013). However, few studies have been conducted about design processes which manufacturers can use easily and effective ways to collaborate between OBM firms and design agencies.

Methods

This exploratory research uses literature reviews, in-depth interviews and case studies. Literature reviews concentrated mainly on acquiring in-depth knowledge about design in existing design processes from academia, professional organisations, international brands and OBM firms. To obtain a realistic view, in-depth interviews were undertaken with key NPD project personnel from international brands and OBM consumer electronic firms, to explore their current problems in operating the existing processes. It evaluates the suitability of existing design processes, examining whether their unfamiliarity with design processes makes it harder for OBM firms to use those processes adeptly during the NPD process. The paper also discusses cooperation between external design experts and OBM firms while considering their ability to manage the increasing complexity of design problems and the more practical level of the design process which can help an organisation implement design effectively and efficiently.

Exploratory interviews with international brands and OBM consumer electronic firms were conducted to capture an overview of design procedures during the NPD process. To investigate a general view of design processes, this study explored three case studies of international brands and three OBM consumer electronic firms (see Table 1). In this research context, the term OBM (Original Brand Manufacturer) refers to a company that retails its own branded products which are either the entire products or component parts produced by a second company (Kim and Nelson, 2000; Bolton, 2009). The OBM-based business develops and sells the products under its own brand name. Transition to an OBM system also means that the company is responsible for the entire process: from production and development, supply chain and delivery to marketing (Bolton, 2009; Kim and Nelson, 2000).

These international brands share a similar attribute in that they are (1) consumer electronic manufacturing companies which are highly competitive in both design and innovation, (2) have an in-house team of designers and engineers and (3) have designed for over ten years to produce their own-branded products and succeed on the global market.

However, OBM consumer electronic firms share a common attribute in that they are (1) consumer electronic manufacturing firms which have transformed from OEM/ODM to OBM during the last ten years, (2) have no in-house design team or a team of fewer than five, and (3) have less experience working with external design agencies during the NPD process. In this research context, consumer electronic products refer to electric or digital products for daily use and other products, ranging from brown and white goods to mobile communication devices and office automation products. The in-depth interviews aimed to understand a general view of what is currently happening in the companies and to identify frequent patterns and common deviations during the design processes.

Table 1: Case study descriptions

Case study	Description
International brand A	A multinational corporation based in South Korea which manufactures a wide range of consumer electronic products and is considered as one of successful business models that had undergone transformation of its business from OEM to OBM during the mid-1980s.
International brand B	A company established in 1917, which formally manufactured optical glass and microscopes and became one of the leading Japanese brands for specializing in optics and imaging products, such as imaging lenses, SLR cameras, digital SLR cameras, compact digital camera, and waterproof film camera.
International brand C	A multinational electronic company based in South Korea which started business in 1958 and became the first company to manufacture radios, TVs, refrigerators, washing machines, and air conditioners. The company has started its business in OEM-based, transformed to OBM. The company employs total 600 in-house designers from headquarters to facilities located in different countries, including India, Japan, UK, China and US.
OBM A	A firm based in South Korea which has manufactured a broad range of multifunction printers, imaging products and office solutions since 1960s. The company has about 50 years of history of being an OEM and ODM subcontracted company to the leading brands of Japan and the US and recently moved upstream to OBM. The firm has no internal design division yet, thus the firm is currently relying on an external design agency to achieving NPD success.
OBM B	A South Korean manufacturer and supplier which founded in 1973, is widely known for its air treatment appliances such as air purifiers and dehumidifiers and water products such as water coolers, water filters and filtration systems for home and the office environment. The business practice started from OEM/ODM for Electrolux and Samsung. The firm has five in-house product and graphic designers.
OBM C	A manufacturer of consumer appliances which has its headquarter and manufacturing facilities located in South Korea; the firm manufactures a range of home appliances including air washers, ionic water purifiers, refrigerators and air conditioners.

Semi-structured in-depth face-to-face interviews were completed lasting approximately 50-60 minutes. The interviews were recorded and transcribed with participants' consent. Transcripts were then analysed to discover future opportunities. The interviews explore the participants' experience and specific events. Prior to each interview, data and information were gathered to understand each participant company. The literature review of academic design processes gathered retrospective data to develop an understanding of the foundation of the design process. In order to compare and analyse different processes, it reviewed international companies' design processes prior to their becoming OBM firms. The key reason which emerged is that international companies have a longer track-record of design and highly skilled in-house design teams. An OBM firm's ultimate goal is to adopt and operate design processes like those of international companies, so it was necessary to review international brands' current design processes to identify the broader processes which may be similar or distinct from those in OBM firms. In reviewing and analysing design processes for OBM firms, the aim was to clarify the distinctive attributes and weaker points in OBM firms, which can be further developed in future research.

An overview of design processes in the academic field

In academic researches and exploration of design processes, across a range of different products, generic product design has many similarities (Bobbe et al., 2016). Although analysis of design processes can include graphical notation, the shape of the design processes (i.e. diamond, V, U, circle etc.), iterative vs. linear notation, this study focuses on the number of stages and activities in each stage of the design process (Bobbe et al., 2016). Academically, the definition of design means problem-solving (Cooper and Press, 1995; Wallace and Clarkson, 1999), and thus developing design processes serves to provide a methodology of problem definition, research, concept generation, evaluation and implementation.

While design processes have periodically been well-defined from the early twentieth century to the present day, they follow a similar methodology or pattern which begins with defining problems, and goes on to solve problems (Hasenkamp, Adler, Carlsson & Arvidsson, 2007; Howard, Culley, & Dekoninck, 2008; Childs, Downie & Katz, 2001). Depending on the different disciplines focusing on the process stages, some models have been developed up to the design implementation stage, others only up to the design finalisation stage. It may therefore be surmised that the implementation of design is related to post-design activities, although in the academic field this may not be regarded as the most critical factor. However, in a context where the design process has a strong connection to industrial use, academic design processes are still impractical for companies to adopt, where it is not necessary to go through every stage of the process (Hollins and Shinkins, 2006).

The model Jones introduced in his book *Design Methods* (1970) is regarded as an example of modern design process which brought objectivity and rationality to the discipline of design (Holston, 2011). Jones saw that less practical traditional design processes often failed to resolve complex problems. Jones's design process model has three stages: (1) divergence, (2) transformation, and (3) convergence. The main focus in the divergence stage is to extend the boundaries of design problems so that designers may explore and understand several dimensions of a problem. Creative action occurs in the transformation stage, turning complicated problems into a simple strong idea. The main goal of the convergence stage is to focus on a solution and reduce uncertainties until the best possible design is identified (Jones, 1992; Holston, 2011). The strength of Jones's model is that it can be used for any circumstances requiring the generation of design ideas; its drawback is that it may be too generalised and concise to share with non-design skilled groups.

Pahl and Beitz's design process model (1984), which is regarded as an engineering method for the conceptual design of a new product, has five stages: 'Planning and Clarifying the Task', 'Developing the principle solution', 'Developing the construction structure', 'Defining the construction structure' and 'Preparing production' (Hasenkamp et al., 2007). This process is one of the models which include the implementation stage because of its connection to product and engineering-oriented processes. The term 'concept' in Ullman's process model (1997) is defined as "an idea that is sufficiently developed to evaluate the physical principles that govern its behaviour." This phase focuses on two specific design activities which generate, evaluate and improve concepts (Pugh, 1991). Cooper and Press (1995) explored a five-stage design process model which includes 'Define problem', 'Understand Problem', 'Think about problem', 'Develop idea' and 'Detail design and test' (Figure 1). The five stages indicate how they develop their thinking and shape their ideas. Cooper and Press (1995) define this model as an internal creative design process, which is more oriented to the designer's inner perspective rather than the context specific.

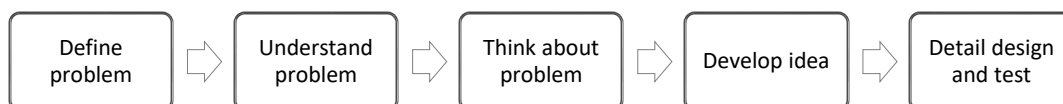


Figure 1: The internal creative process of design (Cooper and Mike, 1995; Design Council, 2007)

Walker (1990) introduces a four-stage external productive design process (Figure 2), based on the core four broad phases and design activities which designers perform (Cooper and Mike, 1995; Design Council, 2007). Unlike other processes, this model has clearly specified design activity objectives at each stage. Hollins and Hollins' design model expands Walker's four-stage design process model into a 'Total Design' (Figure 3), which progresses from market research to production level and environmental monitoring (Cooper and Mike, 1995).

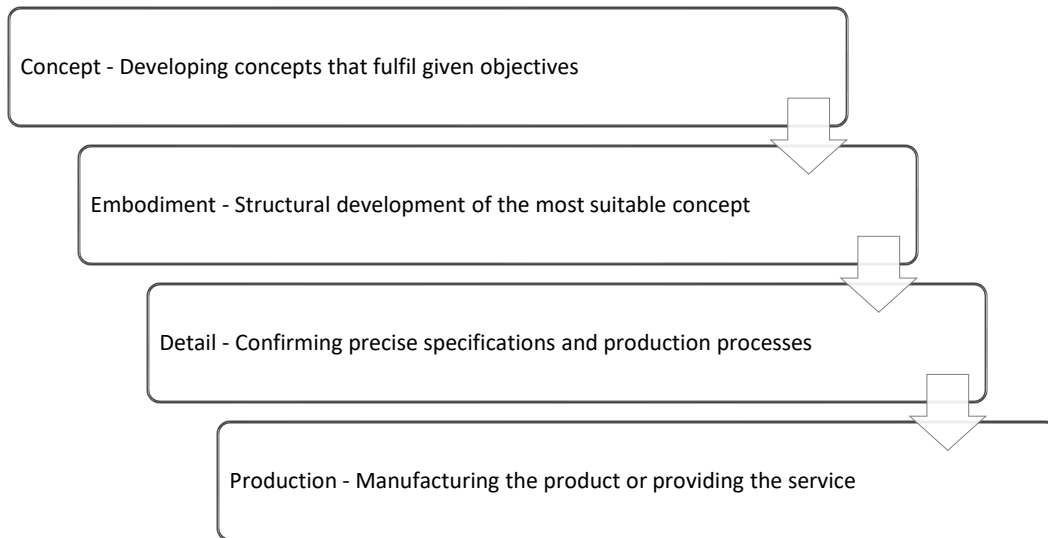


Figure 2: External productive process of design by Walker, 1989 (Cooper and Mike, 1995)

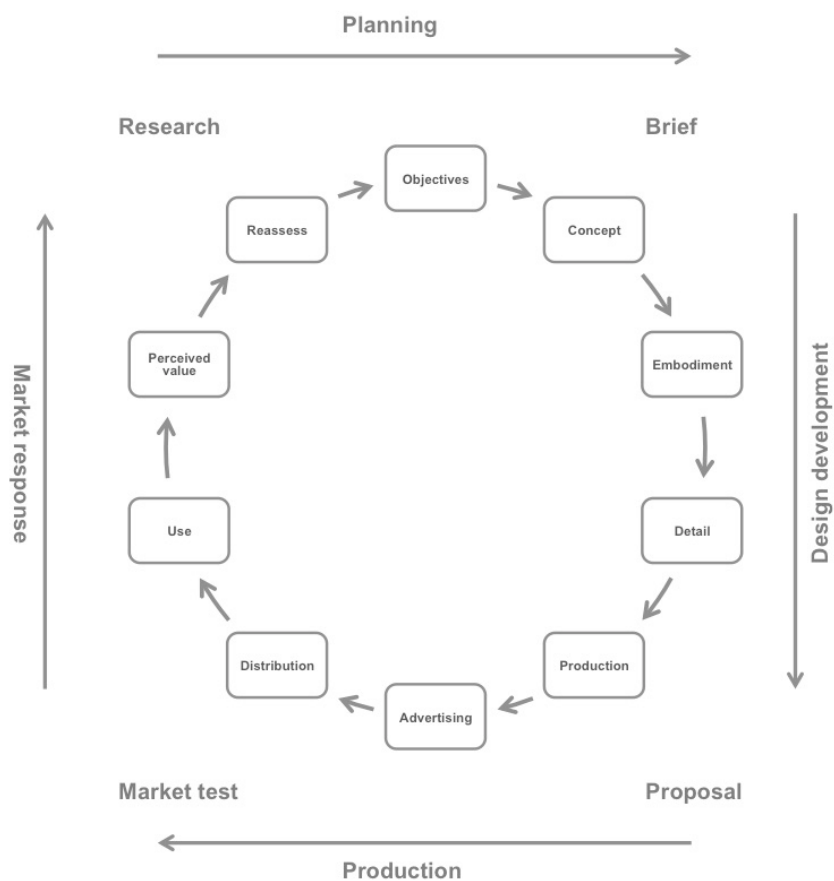


Figure 3: The total process of design within management by Hollins and Hollins (1991) (Cooper and Mike, 1995)

The Design Council researched Western European and United States leading companies' common design activities, where design is used as a strategic tool and business method for their products and services (Design Council, 2007). The design process model in Figure 4 shows a double-diamond shape which incorporates the need for widening and constraining during the design process. The model illustrates the iterative nature of the

design process, repeating the process of divergence and convergence. It shows a similar pattern to John's model which is a generalised concise process to be shared with non-design skilled groups.

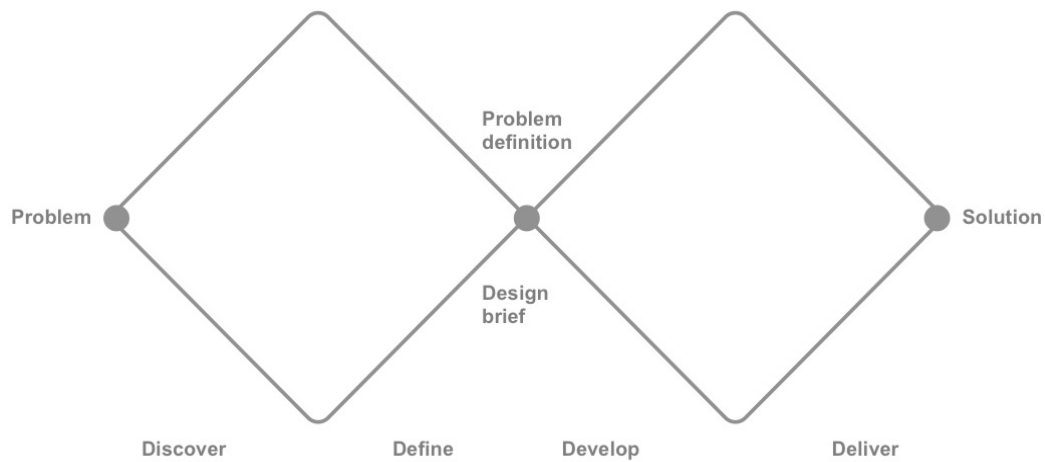


Figure 4: Double Diamond diagram (Design Council, 2007)

Erat and Kavadias (2008) noted that existing product development systems became slower and inadequate due to rapid changes in the industrial system or environment. These changes include various aspects including engineering technology, software, or industry practice etc., (Unger and Eppinger, 2011).

The literature review revealed that design processes in academia are developed into academic debates and generated to support designers, business professionals, engineers in the organisation in improving the effectiveness of practical design work through using, tailoring and managing the process to meet particular aims. However, it is difficult to generalise about a range of design processes because they provide recapitulative tasks or broadly-defined design activities. It is, however, useful for designers who are familiar with design activities and where paths and requirements are specifically defined. Although the core of the design process structures is similar, there is no indication of the duration of the process, the scope or the participants. An organisation with non-designers and novices may find it challenging to apply academic models to achieve design goals effectively and efficiently.

Design processes in business

The priority needs of design in business are to generate profit and gain competitive advantage. Effective use of design and management of its process can thus contribute positively to business performance (Berends et al., 2010). To maintain a competitive advantage, organisations try to attain in the areas of innovation, speed to market, risk management, and an effective work process (Holston, 2011; Westcott et al., 2013).

A design project often requires aligning people from different industry backgrounds, gathering information, and thinking creatively. The role of the design process is to function as a blueprint for the project team, and enable a designer to reach the design solution which enables the organisation to achieve a specific goal (Holston, 2011; Preddy, 2011; Westcott et al., 2013). A design process enables an organisation to understand which roles to hire and how to identify skill gaps, to achieve its goal successfully (Holston, 2011; Preddy, 2011). It will both guide designers through the generic procedure of design activities and help improve overall design quality. Best (2006) states that a design process is the specific series of events, actions or methods by which a set of procedures is followed in order to achieve an intended purpose, goal or outcome.

Design processes in business are set in the middle of new product development (NPD) process, so it is important to examine what the design process itself is like, how the design process starts, and when it happens and ends throughout the entire NPD process.

Design processes from international brands during the NPD process

Collective design processes have been explored and developed both in academia and in the business environment. As companies have realised that design is a key factor in differentiation in the market, by

creating added value to products and services, professionals have continuously modified and adapted design processes to improve quality and efficiency in their organisations (Kanno & Shibata, 2013).

Processes allow organisations to understand workflow, information, communication and project control, enabling them to deal with problems more quickly, increase quality, minimize failure, and ultimately create value for the customers (Holston, 2011). Activities in each design process stage are also extensively employed from problem definition, research, understanding customers and markets, ideas generation, design, prototyping and evaluation to implementation (Brown, 2008).

In the business environment, it is common to have a well-defined linear process format, which enables the organisation to control outcomes by managing uncertainties and risks (Cooper & Press, 1995; Best, 2006; Design Council, 2008; Preddy, 2011). It can identify more efficiently where duplication of effort exists and find areas which are being overlooked (Bruce & Morris, 1994). Organisations often have no absolute design process model, though this varies according to the product type, product lifecycle, organisation culture, the project budget etc., (Bobbe et al., 2016).

While Company A has several design processes, Figure 5 shows one of the standardized models. In a large organisation a design process is influenced by several different factors: the product life-cycle, manufacturing methods and the personnel involved at a particular stage of the process. In Company A's case, the three different types of design processes focus on the consideration of development duration and market release of new products. The model in Figure 5 is used for developing new products to be launched within two to three years. Within the entire NPD process, the design process is usually eight to twelve months, so the internal design team or product planning team spends only a moderate time preparing and planning the project scenario (Table 2). The project scenario comprises a project overview, problem definition, the project goal, objectives, a business overview, a target audience review, competition and competitive positioning, the schedule etc., The design process takes place over about a year, so the internal design team prioritises conducting the target consumer research and extensive market and commercial analysis.

Table 2: A summary of the disciplines and teams of international brands which involve in the NPD process

Stages	Cases		
	Company A	Company B	Company C
Planning	Product Planning or Design	Product Planning or In-house Design or External Design	Product Planning or Design
Create T/F team	X	Product Planning or In-house Design or External Design	X
Initial design dev.	Design	Design	Design
Design embodiment	Design	Design	Design
Prototype	Design	Design, R&D	Design, R&D
Product dev. planning	R&D	Design, R&D	R&D
Quality control test	R&D	R&D	R&D
Production planning	R&D	R&D	R&D
Functional/mechanical test	Design, R&D	Design, R&D	Design, R&D
Mass production/launch	Design, R&D	Design, R&D	Design, R&D
Marketing, Ads	Product Planning, MKT, Sales	Product Planning, MKT, Sales	Product Planning, MKT, Sales
Packaging design	Design	MKT, Design	MKT, Design

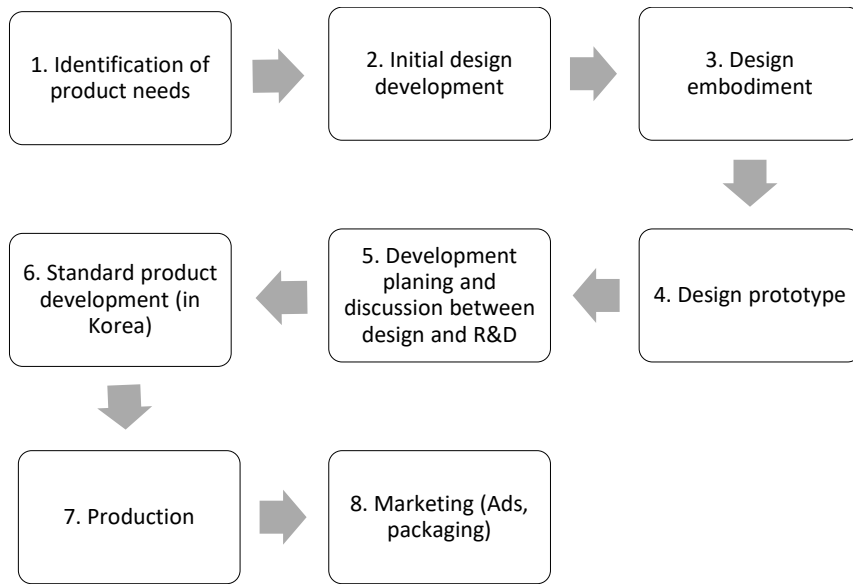


Figure 5: Company A's design process model in the NPD process

The process model in Figure 6 shows a similar procedure to Company A's design process model, however the second stage of the process in which the T/F team is created is unique to Company B. The only difference between the models in Figures 5 and 6 is the various disciplines involved at the early stage, which means that the general NPD approach may be different. The personnel who have completed the first stage will become responsible for leading an NPD project and create a T/F team appropriate for the development of the new product. The T/F team is typically a multi-disciplinary team encompassing product planning, product design, marketing and sales, R&D engineers, system engineering, manufacturing and production control, quality control etc., (Ishihara,2016). Once the project plan is clearly defined and shared with multidisciplinary teams, the design team carries on the next phase to visualise the business plan in a more clear and tangible form. In the third and fourth phases, the internal design team leading the phases becomes a touch-point to communicate with other members.

Company B considers the two early stages as pre-project stages and the most important, time-consuming stages. The first and second stages require sufficient communication to support all team members to understand the process from the earliest phase to production level. Depending on the initial team, the overall NPD approach achieves change and a different result. A few years ago, this company started to reshape the current process model, inviting external design consultancies at the outset of the two stages of the process. Having an external design team more actively involved in the early stages allows the internal organisation to break out of the silo and prevents the internal team from exclusively defining creativity. The remaining stages of the process will be carried out by internal teams or by a combination of in-house and external design teams.

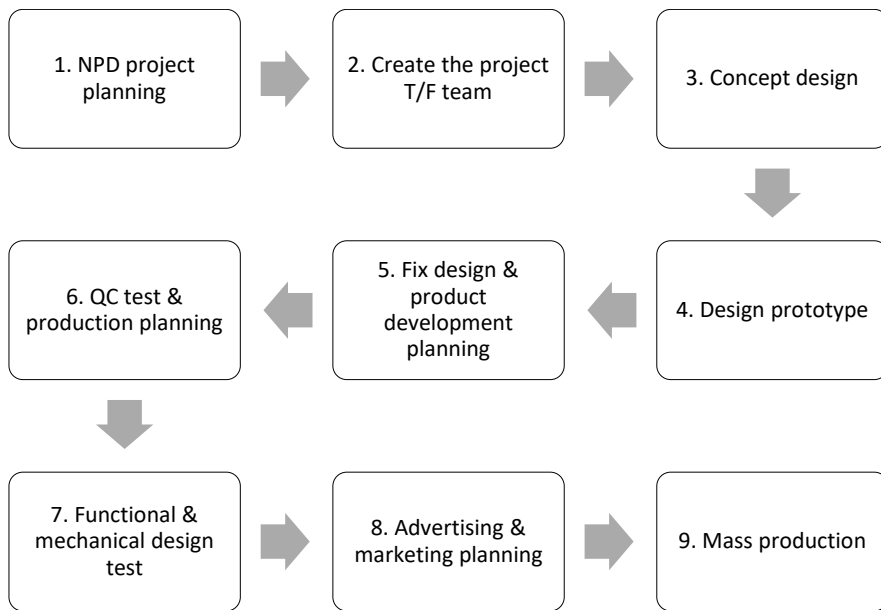


Figure 6: Company B's design process model in the NPD process

In Figure 7 Company C's two distinctive approaches reflect customers' point of views: (1) a customer-following approach and (2) a customer-leading approach. A customer-following approach reflects customer needs in the product concept brief stage, whereas a customer-leading approach depends entirely on insights into customers' latent needs. Company C's process model (Figure 7) has some similar procedures to Company A's, because the major purpose of both process models is to implement a design to production level.

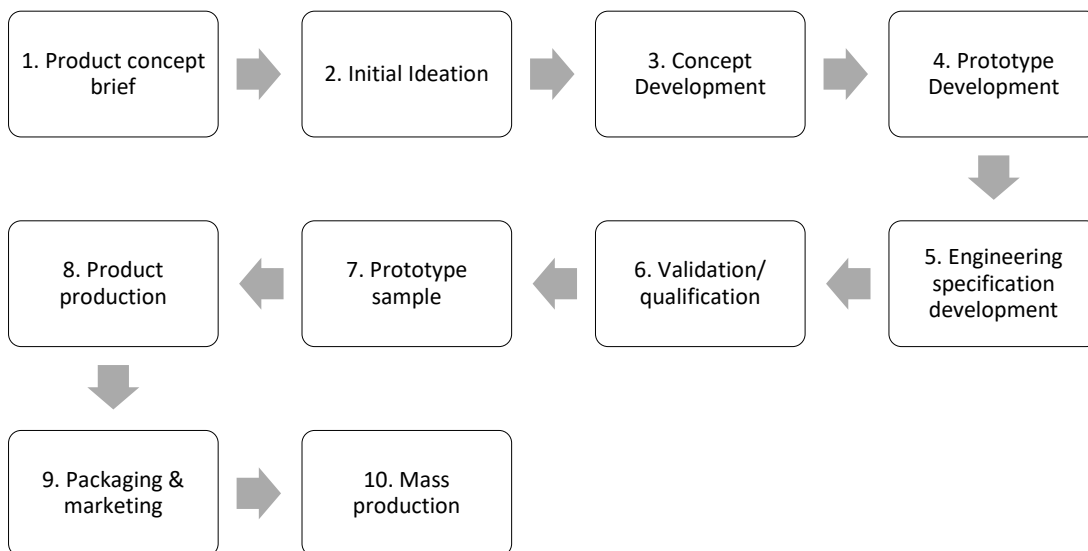


Figure 7: Company C's design process model in the NPD process

In the early stage of the process, either the product planning team or the internal design team plays a pivotal role in defining the new product requirements. The major role is to conduct market and consumer researches, and analyse and discover new insights. However, the company starts to take advantage of a design team at a more integral and strategic level, encouraging the design team to engage with every stage of development from start to finish. It aims to improve the actual design process by allowing a design team to involve a broad spectrum of NPD processes to consistently seek different objectives and needs at each stage, rather than operate as generic procedures.

Design processes from OBM consumer electronic companies during the NPD process

Transformation to the OBM business model indicates that a firm has made the break from subcontract manufacturing and is now producing and selling products with its own brand name through its own distribution channels (Lee, 2013). It enables OBM firms to reach out to a global audience, lead higher sales volume and ultimately drive greater growth and expansion. In order to compete with international brands, it is imperative for OBM firms to enhance NPD productivity to obtain sustainable competitive advantage in the market (Holston, 2011; Chang, Kim & Joo, 2013). However, due to the nature of OBM firms, a NPD project is often highly constrained by budgets and time. Furthermore, the organisation's R&D and engineering oriented culture adds its own constraints to the process for product quality and safety. It drives each process to develop rigorous verification and validation, eventually making the overall design process less flexible and effective.

Table 3: A summary of the disciplines and teams of OBM firms involved in the NPD process

Stages	Cases		
	OBM A	OBM B	OBM C
Planning	R&D	Product planning	Product planning
Create T/F team	R&D	Product planning or Design	Product planning or R&D
Initial design dev.	External design agency	In-house or external design agency	In-house or external design agency
Design embodiment	External design agency	In-house or external design agency	In-house or external design agency
Design prototype	X	In-house or external design agency	In-house or external design agency
Prototype sample 1, 2	R&D	R&D, In-house design	R&D, In-house design
Mechanical engineering specification	R&D	R&D	R&D
Product dev. planning	R&D	Design, R&D	R&D
Quality control test	R&D	R&D	R&D
Production planning	R&D	R&D	R&D
Functional/ mechanical test	R&D	R&D	R&D
Qualification test	R&D	R&D	R&D
Mass production / launch	R&D	R&D	R&D
Marketing, Ads	X	Marketing or Sales	Marketing or Sales
Packaging design	R&D or PR team	Design	Design

Furthermore, for OBM firms where the role of R&D engineers is predominant during the NPD process (Table 3), product quality, verification, safety and validation are also fundamental drivers in the design process. Clarkson and Eckert eds. (2010) discovered that current design processes used by OBM firms are similar to the engineering design process and the product development process. To ensure business survival and growth, the firm needs to expand its scope of experience and knowledge from a manufacturing and R&D engineering base to design and brand management which deliver differentiation and increase value augmentation (Yan et al., 2011; Lee, 2013).

The early stages of the design process in Figure 8 are completed by the R&D engineers by developing mechanical engineering specification (Table 3). After the first and second stages in Figure 8, OBM A invites an external design consultancy to design a new product. It is debatable whether starting to perform design activities after defining new product specifications is the most effective way to achieve successful NPD. The designers' major skill lies in understanding customer needs and rapidly capturing market trends and

translating them into a tangible form (Clarkson et al., 2010). However, in OBM A's case, this limits its full potential. In the fact that the core attributes of a manufacturing-orientated company are speed, efficiency and predictability, from the initial concept right through to production. Stringent control of production costs is critical to business success. Companies are therefore often unwilling to bring in an external design agency until after their own team has defined a specific measurable problem which their own team cannot resolve internally. It narrows the designer's scope limiting their skills to making the most of existing issues rather than approaching a problem in an open and engaged way. This happens to both OBMs B and C, where the entire NPD process is driven by a R&D team (Figures 9 and 10).

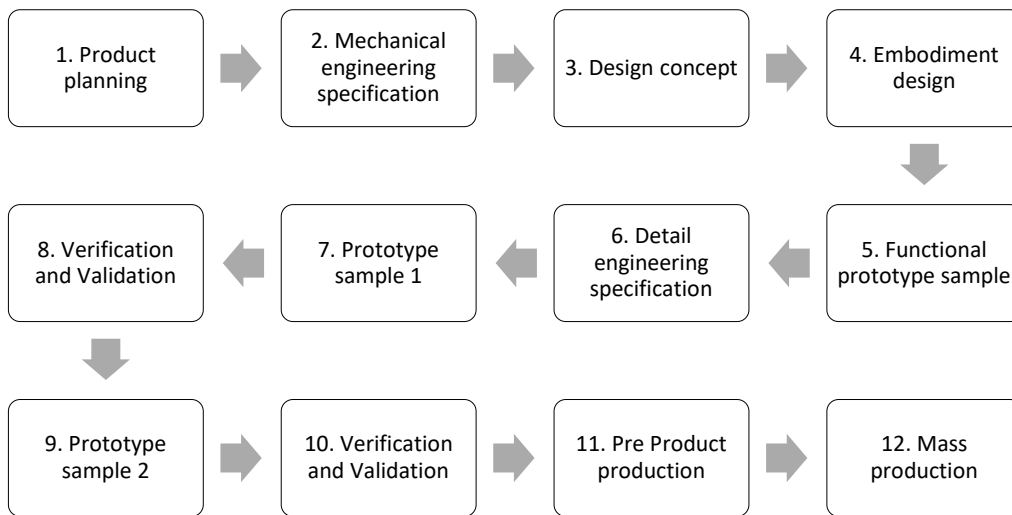


Figure 8: OBM A's design process model in the NPD process

OBMs B and C have in-house design teams whereas OBM A depends entirely on external design agencies (Table 3). OBM A faces three current design challenges:

1. The internal NPD task force team lacks professional design skills and does not understand the design process
2. The firm has no design experience of designing and producing its own product
3. The organization lacks resources for managing the design process
4. The design process is highly constrained by cost and time

Some of these challenges are still relevant to OBMs B and C, despite already having enough resources and design experience.

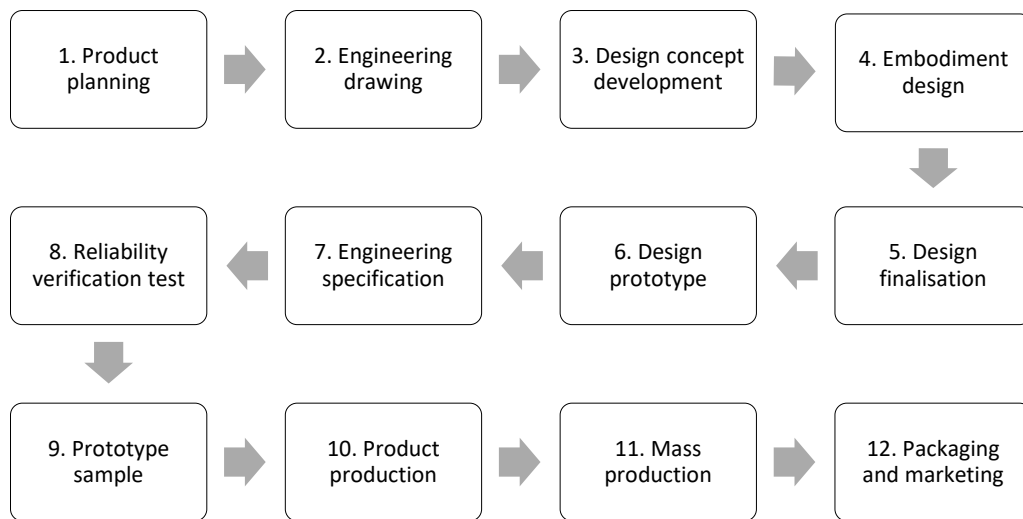


Figure 9: OBM B's design process model in the NPD process

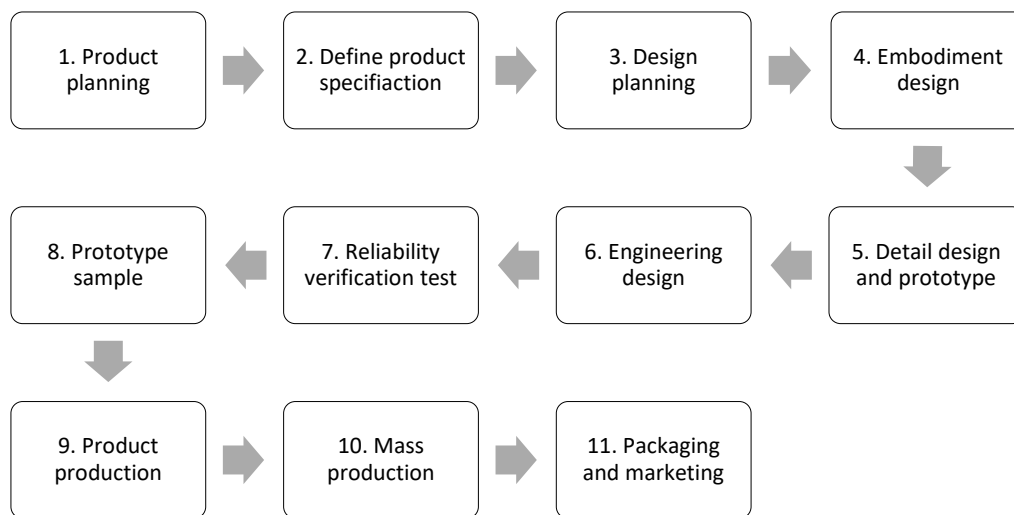


Figure 10: OBM C's design process model in the NPD process

Design processes require management at several levels and the organisation needs to be managed strategically (Clarkson et al., 2010). Former studies, however, have argued that when a non-design skilled organisation co-operates with external design experts, many barriers need to be resolved to achieve successful results (Bruce & Morris, 1994; Bruce, Cooper & Vazquez, 1999; Lewis & Brown, 1999). Researchers also found variable quality of outcomes between the companies with design experiences and those which did not already have them (Bruce et al., 1999). A company without personnel responsible for the design process may achieve a poor-quality design outcome (Cooper & Mike, 1995; Bruce et al., 1999; Lewis & Brown, 1999; Berends et al., 2011).

This research outlines the difference between design processes in academia, international brands and OBM firms, showing how the process can be achieved. It demonstrates that the existing design processes follow the basic design process framework from academia, comprising a sequence of activities from problem definition, research, understanding customers and markets, ideas generation, design, prototyping, and evaluation to implementation. Depending on the different disciplines focusing on the process stages, some models have been developed up to the design implementation stage, whereas others end at the design finalisation stage. Furthermore, different disciplines with different roles seek different objectives, so the design process can be

driven either by the process of design thinking and its implementation or by engineering and manufacturing technology. While companies with a strong in-house design team (Table 2) adopt similar design processes from academia (Figures 1 to 4), OBM firms relying on external design agencies to carry out design activities (Table 3) were less likely to adopt design processes and more dominated by engineering and production based processes (Figure 8 to 10).

The major differences between international brands and OBM firms are the involvement of cross-functional teams in design process. Some researchers have argued that allowing the effective implementation of cross-functional teams is critical to new product success (Kim & Kang, 2008). For OBM firms to achieve effective implementation of the design process, rigorous management is required of the different teams' involvement and appropriate objectives must be clearly stated at each stage. Collaboration between internal cross-functional teams and external teams from the early stage NPD process allows both parties to play a vital role in generating new ideas and the formation of an appropriate design strategy. External design consultancies are able to examine an OBM firm's market, competitors, existing products and consider the customer's perspective. This insight helps a company conceive the type of products and services they should be developing, to set a focused and appropriate scope of the work. It is therefore crucial for external design agencies to step in early in the process, to understand how the company's strategy was developed and find unanticipated ways to represent their strength and value.

Conclusions and the need for further research

The aim of this study is to understand the design process operated by international companies and OBM firms during the NPD process. Academic research on design processes helps to build an understanding of basic design processes; however, all models follow the recapitulative design framework which results in models which are difficult to generalise. While some models from international brands adhere to the fundamental design process notion, some variables may be based on the organisation's specific conditions: product lifecycle, manufacturing methods and personnel involved at particular stages of the process and etc.

This research indicates that it is essential for companies to improve their understanding of the design process in order to commission work effectively from an external design agency. For most OBM firms, overconfidence in their R&D capabilities and novel manufacturing expertise can be particularly damaging to their NPD process. If companies do not manage a full design process, they will continue to produce mediocre products which make little impact in their market. Companies must take full advantage of designers' skills, from unlocking insights to challenging consumers' future behaviours, in order to create truly innovative products which deliver real commercial benefits. This study contributes to the literature by adding findings in process in the practical context of manufacturing-oriented companies to collaborating with either internal design team or external design agencies. The study found that still manufacturing-oriented companies (based in Asia) relying on to the traditional design development processes which mechanical engineering specification occurs before the design process, constraining possible design outcomes.

This study has found some limitations and makes future research suggestions. The small sample sizes limit the research to generalised findings. However, the case study approach collected data by conducting in-depth interviews, which enabled an understanding of intricate issues. The next step is to continue to conduct in-depth interviews with OBM firms and gather further information about their current design processes. The primary goal is to identify current design processes and define the role of the in-house design team during the NPD process. If the firms rely on external design agencies to collaborate with internal NPD project teams, further study of design processes should include design agencies which are experienced in working with both international companies and OBM firms. Design agencies' successful and failed experiences of collaborating with client companies would provide a clearer understanding of where OBM firms need to make improvements or implement countermeasures in their design processes, and identify the ideal role of each functional group in the NPD process.

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