Innovation in the design of a product: A mechanical engineering perspective

Student Name:

Module Name:

Module Number:

Word Count: 3004 Words

Contents

Abstract

The design of products is an intense phase in new product introduction (NPI) and forms the basis of how the final device will impact on is users. Innovation in product design is essential to create an iconic product that captures the imagination of the buying public, and sets it aside from its competitors.

To create truly innovative products undeniably takes a skilled team with vision, but is aided by undertaking market research and finding out what your customers really want, then delivering that in an elegant manner. An innovative design is one that fills all of its design intentions yet is simple and intuitive to use. The innovative product is a product that is instantly recognizable to people in general rather than just users and invokes a sense of being a market leader.

This report will look at what makes a design truly innovative, and will discuss the use of features, materials, and aesthetics to make products that stand out and becomes something that almost everyone wants and strives for.

Introduction

The term ‘design’ can imply or mean many different things. It is generally perceived to relate on how things look, but may also refer to how things work. If the looks are being emphasized, people tend to think of it as decorative or ornamental design, whereas if we consider how things operate, it is considered to be a functional design aspect. Truly iconic designs usually comprise a balanced mix of function and appearance and becomes instantly recognizable amongst its peers.

Design is a much-used word that has been hijacked by all many of trades and where we had simple jobs, people have extended their roles and we now have ‘interior designers, ‘garden designers’, and ‘hair designers who seek to reinforce their professional status by implying that they create the unique and the innovative.’. Product design has become inextricably entwined with the perception of upward mobility, extravagant consumerism, and even street style as almost everything now carries the term ‘designer’ before it, implying that it is above average and therefore increasingly desirable.

But true innovative design is not about a product that is a little less mundane than another similar product; it is about a product that becomes instantly recognizable while being functional and offering something new that users embrace as a startling change. Until 1890, handguns used in America and throughout the world were variations of the cylindrical revolver, but that was challenged by the workshops of Henry Colt and the development of the recoil-operated automatic handgun, based loosely on machine gun designs. Even today, the Colt.45 automatic – known as the M1911 – is instantly recognizable and beloved of mercenaries and African dictators. Its design was iconic and its function exceptional and it has barely changed over the last 100 years and was the standard American military side arm in the Second World War, The Korean War, and Vietnam War. This is a classic example of an innovative design that has created a new way of thinking that has challenged the conventional wisdom, and has been copied extensively.

The remainder of this report will examine what makes product design innovative, and will feature various examples of both good and bad design innovations.

Aim and Objective

The aim seeks to explain the role that mechanical engineering plays in design innovation and the impact this phase has on the final product. The objective will explore the areas in the design process where mechanical engineering changes and approaches help to cause product innovations, and discuss the relative merits of getting to market fast against taking a more pragmatic and structured view of the what the market really wants.

Literature Review

Modern design has its roots firmly fixed in the industrial revolution (Clark & Freeman, 2003), but has blossomed during the 20th century as an increasing number of individuals and companies have become involved in product design and innovation. The 1790's became the start of designers starting to *routinely* use detailed technical drawings to visualize their design, and ensure that they conformed to certain standards (Rovida, 2013). That meant that a design could be accurately manufactured by anyone with sufficient engineering skills, and it started the move towards standardized production methods and processes (Munford, 2009). It also means that the designer could visualize their intended product accurately before it had been made, and that in turn meant that their creativity could be used to the full. The rise of standard design tools turned the engineer into a creative force (Hentschel, 2014).

Ullman (2010) tells us that the key to innovative design is creativity and the creative mind, and without a mind able to visualize what might be, then true design innovation might not ever be achieved. Ullman (2010) goes on to state that creativity can be broken down into four sub-sets; environment, product, process, and person – and the person category can be further broken down into cognitive and psychometric factors. Using these skills, designers today need to be able to go beyond the usual construction of mechanical structures and visualize where a design could go to make it truly innovative (Roberts, 2011).

Architect and designer Christopher Alexander attempted to classify design-oriented thinking by listing all the requirements of a proposed design and then tried to characterize the interactions between those stated requirements (Lawson, 2005). For example, he would state that fewer materials made for a more efficient factory as there were less need for joining processes. Therefore, he would state that as many parts as possible needed to be made out of the same materials. Similarly, forming processes should be kept to a minimum – again to simplify the production area – and designs should be based on a minimum number of processes. Having noted down all of the characteristics, the designer would review and reduce them to make for an unfussy design.

There has been much criticism of this mode of design, which has been dismissed as too simplistic and prone to restricting the design process (Lawson, 2005). The Alexander Process isn't used as a serious design tool since it disallows innovation and drives the designer along certain, ridged, paths. Modern thinking has identified that advanced, and even risky, product innovation is one of the driving forces in pushing the barriers of design, and creating ever more radical products (Verganti, 2009). In addition, Verganti (2009) states that while some products are undeniably simply that, and people buy them because the need them, others are seen much more as profound psychological meaning and they buy to fulfill some personal desire that they relate to. He argues that because design innovation is not constrained to simple needs of the user, product development follows two paths; vast leaps forward that encompass technological breakthroughs, and incrementally improved products based on user or market feedback.

War has been called the mother of invention, and undeniably the defence industries spend a sizable proportion of their budgets on research and development or R&D as it is referred to (Finn & Jain). The goal with defense innovation tends to be long term, with products and systems being decades in development but having significant impact once released. However, this can be a wasteful exercise if other allied defence institutions are working on similar products and there are increasing moves to ensure that duplication doesn't happen. In the case of the European Union and European Free Trade Association member states (EFTA) the Defence and Security Procurement Directive (DSPD) is intended to create an atmosphere of increased completion with decreased duplication and hopefully lower prices for any member of the economic area. Studies into the effects on the Norwegian Military (Blom et al, 2013) found that the effects of policy intended to strengthen links between defence industry companies in the European economic region actually created visible divisions between those companies as they tussle to win lucrative international defence contracts. Furthermore, the report found that the directive did little to stem the competition between companies. The report also found that intervention in the form of the directive did not lead to any significant swapping of information on projects that they are engaged in. This was partly because of the need for secrecy regarding unpatented ideas that they may have and to protect the potential profits that could be gained from being the sole supplier for advanced and innovative weapon systems.

But defence isn't just about weaponry and a countries military budget will go towards many other areas of the industry with meaningful spend going on ancillary items such as vehicles, uniforms, and infrastructure, much of which also offers direct opportunities to innovate. Mitchell (2012), points out that much military equipment is purchased with the intention of modifying it in some way depending upon the war zone it finally finds use in, and flexibility is a key factor in a design. This means that development teams must apply a certain amount of future-proofing to their designs while ensuring that they remain relevant to the project specification (Thomke & Reinertson, 2012), but those two factor need to be considered together with the need to innovate and get to market as fast as possible. The need to get products out in a short a time span as possible not only ensures that innovative ideas are patented and manufactured before a competitor can do so, but cuts down on development costs, and those can be significant, particularly in the defence industry.

Reinertsen (1998) points out that by innovating quickly, engineering and technology companies can increase sales by occupying new market positions quickly and for longer, beats competitors and creates a mindset of an innovative company, and cuts back on development costs. But accelerating development times is a tricky process that has to be handled properly. Thomke and Reinertson (2012) point out that many companies treat development as an extension to standard production, but the truly innovative team recognize that they are fundamentally different processes.

Furthermore, Reinertsen (1997), tells us that the route to fast development is actually a management process rather than purely engineering driven and it requires close focus on what the innovation is, and what it is intended to do within the market. This will prevent '*specification slip*' where an engineering team try to add too many innovative ideas and end up extending the development phase unnecessarily. Specification slip can lead to delays in getting to market, but can also affect the reliability or quality of the final product. Fast development must follow strict and specific rules if it is to be completed satisfactorily (Baker, 2009), and that means that the management team overseeing the development must understand what is being achieved, and the timescales required.

Mootee (2013) points out that for many companies, design innovation is the reason for existing and to not get it right can mean serious disruption for a company and may even result in severe and possibly unsustainable financial loss. In order to prevent that design innovation is too important to be left in the hands of development engineers alone (Mootee, 2013), and senior management must retain control of the process to ensure that it is carried out in a proper manner to prevent problems occurring.

Discussion

Product development is generally accepted to be a period of intense activity which results in a design conforming to some previously agreed set of rules or specification. The specification will, in most cases, be generated based on what a particular company believes its customers would like to have, and that in its self is usually decided by market research. Truly bespoke innovative design is something that astounds with its audacity but becomes so obvious, that you wonder why it hasn't been thought of before. One such concept design that has real practical uses is the Sony bracelet Computer, which is expected to be available as a product by 2020, and is expected to become not only a big seller but also a device that will be endlessly copied. Designed by Hiromi Kiriki, the bracelet computer is wearable tech that can be removed and used as a small personal computer. Designs such as this have been made possible by advances in the fields of micro-electronics, bendable screens and advanced polymeric materials. Kiriki has shown that the concept is possible, and now others will apply their engineering knowledge to creating similar products.

Innovative design is infectious; once a new concept has been designed, others will try to emulate it in order to take a chunk of the market that it is likely to generate. This is particularly true of technology products which tend to capture the public's imagination and self-generate a market where one didn't exist before. These are typical of the purely innovative type of product where nothing similar exists in the market, but once a product hits the market, it can become the latest 'must have' device. A market suddenly exists where there wasn't one before and potentially enormous revenue is generated because of innovation.

Innovative design has become an enormous driving force in mechanical engineering and the need to come up with increasingly revolutionary products is a major part of many companies. Tech giants like Sony, Apple, Samsung, and Dyson exist to innovate; they are companies that expand a huge part of their development budget on innovation, and while much of it is incremental in nature, there is still significant patentable product being developed alongside it.

The issue of patents is one of the big driving forces within engineering as a company will develop something new and unique which looks to be a huge commercial success. But before they release it they will ensure that their Intellectual Property rights (IP) is fully written up and the device or even the principles behind it cannot be copied. In light of that, rival companies are forced to look for new and novel solutions to a factory-fresh product which they cannot copy part for part. That puts an enormous amount of pressure on engineering teams to look at peripheral and emerging technologies as they search for solutions which will allow them to market a rival to a new product.

This is known as ‘me-too’ product development and it puts an organization or Engineering team in a position of catch-up with others who have already innovated. But that can actually put companies in a better position. While the iPod was certainly not the first digital music player, it has become recognized as one of the most effective and desirable, putting it in a front-running position. Me-too is much more prevalent in the pharmaceuticals and food industries with shelves stocked with ‘own brand’ products; McDonalds copied the idea for fast food restaurants from an earlier chain called White Castle, but they did it better and therefore became the company of choice for many fast-food users.

Mechanical engineering does not offer so many opportunities, so it is unusual for a product to become bespoke simply by changing the packaging as with many consumer brands. Thus the task of creating revolutionary products that will capture the imagination of the public and that becomes a massive hurdle for companies. However, with a little thought, there may be huge opportunities in placing an existing type of product – or something based on it – into another area. This has been encapsulated by engineering company GoPro, who recognized the growing market for extreme sports together with expanding social media outlets and decided to break into it. Go-Pro took the then current technology in small high-definition video cameras – a product that was already well defined - and developed a whole range of wearable and mountable mechanical products that would allow the user to take high definition video whatever they were doing. GoPro have added waterproof cases and steady-mounts enabling the user to share their moments, regardless of what they were doing or how active their pastime is.

The GoPro product range hit the market just at a time when people were looking for just such a system, and while their range are seen as expensive and at the top end of the market, they are still the market leader and realize significant sales revenue. There have been many copycat products hitting the market, but GoPro have managed to continue to dominate the market by introducing new features such as Wi-Fi upload, Bluetooth connectivity, and LCD touchscreen capability and this constant update of the basic camera device keeps them ahead of their competitors.

Similarly, Dyson, the vacuum cleaner company, hit upon the concept of the using cyclonic separation in their cleaner systems to create an effective and bagless system. The cleaning or changing of filter bags on vacuum cleaners was seen as one of the main problems with the devices. James Dyson – an industrial designer who had already invented the ball-barrow as an extension of the basic wheel barrow product – designed the product which is based on the notion that dust particles will be thrown out of a column of rotating air by centrifugal force to be collected in a separate bin. It completely removed the need for a bag which needed periodic changing, and therefore saved, time and money. Dyson found that he was effectively blocked in the UK by the manufacturers of bagged vacuum cleaners, who refused to manufacture it under license as they saw the effects that his new cleaner could have on the replacement bag market.

Eventually Dyson sold his product in the Far East and built an empire that has focused on innovation in mechanical engineering for a number of different areas. He has continued to invest in the vacuum cleaner market, but these tend to be incremental updates rather than truly innovative designs. The real genius is in Dysons other products, which include the air-blade hand dryer, the contra-rotating washing machine, and the air-multiplier bladeless electric fan.

With just these few examples, the intellectual abilities of engineering teams and the far-reaching products that they first envision and then strive to manufacture is obvious, but it is also obvious that the need to create innovative products that capture the imagination of the buying public, or military suppliers must be must be cost-effective and properly managed.

Conclusions

Plainly, design innovation is now entrenched in the mind of both the public and the Engineers who supply them. Engineers and designers recognize the need to innovate – particularly those in high technology and defence organisations – but also to do it as quickly as possible to prevent being either left behind or missing out altogether. We have seen that the pharmaceutical industry is a special case and while constantly innovating, they must take time to prevent catastrophic failures in the field, but this isn't the case with mechanical engineering where there may be many different ways to achieve the same result and thus are under pressure to become a market leader in a new innovation by being the first on the market.

However, we have also seen that being the original does not necessarily mean that a product will become a market leader and there are interesting points regarding analyzing a new product and determining whether it can be achieved in a better and more cost-effective way.

References

Baker, P. (2009): *Just Develop It: Managing the Fast-Track New Product Team*. FT Press, New Jersey.

Blom, M, Castellacci, F. & Fevolden, A. (2013): *The trade-Off Between Innovation and Defence Industrial Policy*. [Online] Available from http://www.sciencedirect.com/science/article/pii/ S0040162513000061. [Accessed 8th December 2015].

Clark, P, & Freeman, J (2003): *Design: a Crash Course*. 2nd Ed. Watson-Guptill: New York. Pp 10-11

Cross, N. (2008): *Engineering Design Methods: Strategies for Product Design*. 4th Ed. John Wiley & Sons: Chichester. pp. 6-11

Finn, A & Jain, L (Ed's) (2010): *Innovations in Defense Support Systems*, Springer-Verlag, Berlin.

Hentschel, K. (2014): *Visual Cultures in Science and Technology: A Comparative History*. Oxford University Press, Oxford.

Lawson, B. (2006) *How Designers Think: The Design Process Demystified*. 4th Ed. London: Elsevier Publishing. pp. 31-33.

Mitchell, S. (2012): *Innovate or Suffocate: UK Defence and its Response to a Disruptive World*. [Online] Available from http://www.paconsulting.com/our-thinking/innovate-or-suffocate-uk-defence-and-its-response-to-a-disruptive-world/. [Accessed 9th December 2012].

Mootee, I. (2013): *Design Thinking for Strategic Innovation*. John Wiley & Sons Inc., New York.

Munford, P. (2009): Technical Drawing Standards: A Brief History. [Online] Available from http://cadsetterout.com/drawing-standards/bs-308-and-all-that/. [Accessed 14th December 2015].

Reinertsen, D. (1997): *Managing the Design Factory*. The Free Press, New York.

Reinertson, D & Smith, P (1998): *Developing Products in Half the Time*. John Wiley & Sons Inc., New York

Roberts, D. (2011): Skillset: The Beginning Engineers Checklist. [Online] Available from http://makezine.com/2011/03/30/the-beginning-mechanical-engineers-checklist/. [Accessed 14th December 2015].

Rovida, E. (2013): *Machines and Signs: A History of the Drawing of Machines*. Springer, Heidelberg.

Thomke, S. & Reinertson, D. (2012): *Six Myths of Product Development.* [Online] Available from https://hbr.org/2012/05/six-myths-of-product-development. [Accessed 11th December 2015].

Verganti, R. (2009): *Design-Driven Innovation*. Harvard Business Press, Boston, Mass.