A STUDY OF OPEN INNOVATION AND ITS APPLICATIONS TO PRODUCT DESIGN

By

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Submitted to the System Design and Management Program in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Engineering and Management

at the

Massachusetts Institute of Technology

June 2013
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Abstract

The rapid development of the internet and social media have democratized the innovation opportunities for small startups and individual innovators. This is creating more ways for companies to exploit external ideas for their internal innovation. The dominant use of open innovation today is in idea generation. However, some companies have gainfully applied open innovation across other phases of product development, including concept development, detailed design, manufacturing and sales. The academic literature in this area is rapidly evolving and is covering many different concepts associated with open innovation. At the same time, product development processes are also evolving and are being integrated with more digital tools and electronic workflows. Although many companies are saving R&D costs by utilizing open innovation methods, there clearly is a need to understand the right open innovation tools and processes to maximize the returns from this strategy; one approach does not fit all. This thesis builds a taxonomy of open innovation and discusses its applicability to modern product design processes. This thesis studies the applications and benefits of open innovation in all phases of product design, and suggests strategies for an optimal mix of open and closed innovation processes and tools applicable to modern product design. Challenges in incorporating open innovation and managerial strategies to overcome them are also discussed.

Thesis Supervisor: Steven D. Eppinger
Title: Professor of Management Science and Innovation, Co-Director, MIT System Design and Management Program
Acknowledgement

I would like to express my most sincere gratitude to Professor Steven D. Eppinger for his guidance, support, and encouragement throughout the development of this thesis. I am indebted to him for keeping my focus on the topic, for multiple discussions and reviews, and insights that I gained by taking his product design class. My association with Professor Eppinger has been one of the best learning experiences in the entire SDM program.

The motivation for this thesis came primarily from the Product Design class taught by Professor Steven Eppinger and theory of User Driven Innovation taught by Professor Eric Von Hippel. I have had the privilege of taking both these courses during my academic semesters at MIT. This thesis is also influenced by Christian Terwiesch’s work on Innovation Tournaments and Karim Lakhani’s course on Innovation Management at Harvard business school.

My gratitude goes out to my friends at MIT and Sloan School of Management, who have contributed to this thesis in some way or other. I consider myself privileged to have a chance of collaborating with one of the most rich and diverse cohort amongst all programs at MIT. I would like to thank Pat Hale for giving me the opportunity to be a student in one of the finest programs at MIT and Sloan School of Management. Special thanks go out to all those who worked with me during my stay at MIT.

Most Importantly, I owe this work to my wife Faria, for always being there for me, encouraging me and patiently waiting for her share of those little moments of quality time during my school year, which was also the first year of our marriage. I thank my parents for their love, constant support and encouragement from across the miles. Thank you Mother, for encouraging me to pursue my dream. Despite of the physical distance, I always felt you were with me every moment as I lived our dream at MIT. This work is dedicated to you!
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1 Introduction

We use hundreds of products in our everyday life ranging from something as straightforward as a toothbrush to something as complicated as a smartphone. Many products and services have strongly influenced the way we do our tasks. At the same time, these products and services have evolved and sometimes transformed to better fit into the user’s workflow. Over centuries, there has been this iterative feedback between needs and solutions with one shaping the other and vice versa. Out of curiosity I dug up the history of toothbrushes and found that it took almost 150 years from the first “modern” design to something reasonably close to what we see today. The first mass produced toothbrush was invented and produced by William Addis in 1780. Until the invention of nylon by DuPont in 1938, the assembly process was manual wherein swine bristles were manually drawn into cattle bone using wires. After 1938, the process was mechanized, and automated manufacturing took over. Again, in 1960, first electrical toothbrush was invented that created a new product category and a new market and changed the way consumers used the toothbrush before. The toothbrush we see today is pretty much the same what we had in midcentury, barring few incremental improvements every product refresh cycle.

On the other hand, if we take the example of mobile phone, the design has changed significantly in last 10 years. It is ever getting smaller, faster and more useful. Thousands of different models exist in the market, and in every six month, cellphone manufacturers are surprising customers with an entirely different model with unimaginable features and functions that create new uses of the device. In general, a plethora of new products are launched every day for covering applications from different walks of life. Product life cycle is getting shorter as hundreds of new product startups develop new technologies and realize them into successful new products every year. Why is the innovation cycle today so much faster than before? What has changed in the innovation ecosystem in past 10 years? What innovation strategies must the incumbent use to cope up with the shorter product lifecycles? What is open innovation and how is it relevant in the context of contemporary product design? The rest of this chapter will discuss some key challenges in modern innovation processes including those in open innovation. The concept of open innovation discussed and contrasted with the traditional closed innovation paradigm. Finally, the research questions and research methodology will be discussed.
1.1 Innovation as the lifeblood of Product Companies

Jim Utterback, professor at MIT developed a theory of innovation dynamics for product or services. Any product or service goes through phases of experimentation to maturity. Just before the maturity phase, a dominant design is evolved which ends all the experimentation and slows down speed of all radical innovations related to the product. The following is the innovation dynamics observed across various industries by Utterback (J. M. Utterback, 1996).

Figure 1 summarizes Utterback’s theory, which states that the rate of innovations is quite high at starting phase of any disruptive new product. A lot of companies battle for supremacy pitching their own solutions to problem being addressed. However, as the product matures, and reaches to a dominant design, majority of the companies exit and very few that have superior engineering manufacturing, distribution capabilities sustain in the market. The radical innovations slows down and differentiation is achieved by incremental or sustaining innovations. After a certain period of time, a new technology or product displaces the older one the cycle repeats. The new technology or product is better than the older one on some ancillary performance dimension but it may be worse in the traditional performance dimension. Over time, the traditional performance dimension also improves and the older product or technology gets replaced by the new one. This is the concept of discontinuous innovation introduced by Utterback (J. M. Utterback, 1996) and popularized by Christensen by the term disruptive innovation (C. M. Christensen, 1997).

Giachetti et al. studied the mobile phone market and collected data for the disruptive changes in the mobile phone product over the span of 15 years(Giachetti & Marchi, 2010).
It can be seen that a major innovation has been done to the mobile phone product almost every year. Also, it’s not a single company that brought all these innovations that we see in a mobile phone today. While Nokia was the leader in late 90s, Sony, Sharp and Samsung changed the game by bringing features like mp3 playback and a camera. Motorola brought Wi-Fi and a PDA functionalities. Interestingly, Moto Razor was the first phone using iTunes for synchronizing music files, before iPhone launch. After the invention of capacitive multi-touch, and touch screen gestures the market was completely taken over by Apple’s iPhone and other manufacturers, which were once market leaders, are now playing the catchup game. Apple’s iPhone has been a major disruption for Nokia, Motorola, Sony and Blackberry and it’s a relatively new product just 6 years old. Today, even Apple’s dominance is in question from the likes of Samsung and Google which are putting in many more innovative features like Near Field Communication and wireless charging in their phones. The above mentioned case illustrates the pace in innovation and lack of monopoly (NFC) in mobile phone industry.
However, the same is true for most other products that are being developed today. Companies are churning out products faster than ever before. One reason for that has been lots of disruptions in digital and internet technologies helping products and technologies across different unrelated sectors. The free flow of information and democratization of resources has lowered the barriers to entry into a product market. We are living the era of *Digital Disruption*, which is shifting the innovation paradigm.

In this age of digital disruption, anyone can innovate by using cheap or free digital tools to change products as low-tech as the toothbrush or kitchen knife. Digital tools are used to change to change the way a product message is conveyed. The online store provide an excellent retail platform for selling the product or delivering a service. Real time product feedback and sales forecast can be obtained from the online community pages on the internet. This does not only apply to software and services, but also to physical products like beverages, T-shirts and even cars. Every company is today is digital, no matter how physical are their products or processes.

1.2 Innovator's dilemma and Open Innovation Strategy

Digital disruption has helped startups bringing new technologies to market. For the incumbents, this has posed challenges to stay competitive. Incumbents always have to be on a lookout for acquiring promising technologies or reinventing themselves and overhaul there product portfolios regularly. According to Christensen, the simplistic idea of “keeping up with technology” is inadequate and does not model the reality. Good companies are usually aware of the disruptions happening in the industry but their business environment does not permit pursuing them because these innovations are not profitable at first. The dilemma is to keep their scarce resources in sustaining innovations and stay in the existing competition vs. placing a bet in some far horizon opportunity and either winning or losing it all (C. M. Christensen, 1997). This becomes even more challenging in lean times when the incumbent needs to cut the costs while keeping growth options (innovations) open for the future. More often than not, the incumbents chose the strategy for short term profitability and rigorously prioritize the sustaining innovations that best fit with the its core business. This rigorous prioritization kills many promising opportunities in their early development cycle and also stops the internal ideation and external sensing of ideas. This strategy increases cash flow in the short term but
hampers ability to grow beyond the core business. Henry Chesbrough proposes a solution to this dilemma in his article on Open Innovation (H. W. Chesbrough & Garman, 2009). More specifically, he proposes the “inside-out open innovation processes” wherein internal projects are opened up to external venture and development firms. Some also refer this as spin offs wherein the parent company separates out some projects in return of some equity in the newly created firm. This strategy not only helps bring focus to the core business, but also helps in creating new relationships and innovation networks to promote internal technology and generate high gross margin licensing income. In addition, outside-in open innovation strategy can also be used to obtain new technologies beyond the scope of company’s core business. More details about inside out and outside-in processes are discussed in section 3.3.

In the chapter 3, some portfolio and prioritization tools are discussed to select between the generated opportunities. Those tools combined with open innovation philosophy can help make decision about the proper mix of short term and long term opportunities.

1.3 Key Challenges in Corporate R&D

Frost and Sullivan (Sullivan, 2012) conducted a survey in 2012 to understand key challenges in corporate R&D and product development. The survey was designed for manager level and above R&D and product development executives from companies throughout Europe. The following are the key results from the survey based on 83 responses (Sullivan, 2012).

Top Innovation and Product Development Overarching Challenges:

- **Portfolio Management**: A methodology to help prioritize innovation projects based on the economic value and strategic role of a product in the portfolio.

- **Collaborative Innovation**: Methods to collaborate with customers, adjacent businesses, outside innovators and suppliers.

- **Open Innovation and Partnerships**: Challenge in integrating open innovation to the product development process, and establishing trust with strategic partners.

Top five R&D/Innovation and Product Development Challenges

- Generating an accurate and relevant technology roadmap (16%)
- Identifying breakthrough new product ideas (13%)
- Managing an open innovation process (15%)
- Prioritizing innovation ideas and projects (15%)
• Streamlining research, design, and development activities to reduce costs (10%)

Generating an accurate and relevant technology roadmap is the primary challenge of R&D/innovation executives.

The survey also suggested that the cause for the top three challenges was attributed to staffing constraints: Either insufficient personnel (71%) or inadequate skills (29%). In comparison to 2011, budgets are expected to increase, but staffing levels will remain static in 2012. In most of the organizations participating in the survey, little or no staff was assigned to open innovation. If open innovation was pursued at all, it was primarily for idea generation. Even the companies, that had practiced open innovation, were blocked on the challenges like:

• Measuring the impact of open innovation on product development efforts

• Transaction costs involved in coordination of open innovation and measurement of benefits out of it.

The lack of process (29%) or ineffective process (40%) was another top reason for streamlining R&D and managing an open innovation process. 58% of the executives surveyed rated their R&D or product development function’s effectiveness to be either average or below average as compared to the industry. 42% of the respondents employed a part time or full time staff dedicated to open innovation. The median size of the staff is 3 which is a low number compared to the conventional R&D staff size.

Here are the top 5 open innovation challenges from the survey (Sullivan, 2012):

• Measuring impact/effectiveness of open innovation product development efforts (17%)

• Assessing the feasibility of a potential partner (18%)

• Promoting trust between employees and external partners (16%)

• Creating a shared understanding of the problem to be addressed through open innovation. (20%)

• Finding external partners with suitable IP to solve the problem (18%)

1.4 Managing the Innovations “Process”

From the frost and Sullivan survey, to top overarching R&D challenges for 2012 were:
- Portfolio Management:
- Collaborative Innovation
- Open Innovation and Partnerships

All of the above four results suggest a lack of methodology and structure in the innovation process. The medium and extent of collaboration with customers, suppliers and external innovators is outdated and inadequate. There is still a lack of understanding of benefits of open innovation and an inertia to accept this new paradigm. The processes for innovation are not set in stone even for big innovative companies like Apple, Google and IDEO. On a lucky day, one may hit a million dollar idea while waiting for years for the next one. Innovation management is important to bring some repeatability and deterministic measure of return on investment on the dollars spent on R&D. It becomes even more important when external sources of innovation are involved in the company’s innovation process. Since the probability of getting a very good idea is small, like a lottery ticket, the best bet for a firm is to generate as many ideas as possible to increase the odds of hitting a jackpot. Along with quantity, quality of the ideas and high variance among them is also important (Girotra, Terwiesch, & Ulrich, 2010). Using external sources of innovation from a diverse selection ensures both quantity and variance in ideas. The frameworks discussed in the later sections of this thesis can be used to select a set of best opportunities and include them into the innovation pipeline. Furthermore, the opportunities generated with the help of external sources can be converted into bestselling products using the open innovation methods and tools mentioned in the later sections of this thesis.

1.5 The paradigm shift

20th century marked the success of closed innovation paradigm with lots of High quality innovations coming out of the best corporate run labs in the country. Companies like Xerox, IBM, HP, AT&T and DuPont made breakthroughs in technology and even won Nobel prizes for their respective discoveries. IBM had a monopoly in the Mainframes. Xerox produced the most advanced copiers and had the lion’s share of the copier market. Each of these big companies had their own labs and fully funded R&D program. Companies which could fund more money into research generally enjoyed development of more advanced technology. This
R&D investment itself was a big barrier to entry for the smaller firms. Companies, which were unable to fund their R&D similar to their competitors, did not sustain in the market.

![Figure 3 Closed Innovation, [Chesbrough 2003]](image)

The above Figure 3 illustrates the closed innovation paradigm wherein all the development is kept within the walls of the company. Internal resources and funds are used and the entire value chain from R&D to commercialization is vertically integrated.

While vertical integration and in-house R&D capability used to be a competitive advantage of companies, the Internet has negated any such advantage by providing equal opportunities of innovation to everyone. Information and resources are available to everyone large or small, and as Eric von Hippel would say, “innovation is democratized”. Earlier, a company could cash on the success of a good product for years. The distribution channels required relationships and scale of organization. Once the distribution channels were set, they were a source of competitive advantage. R&D expenditure was correlated with the amount of innovation done in the labs. However, today, all such advantages are eroded. Internet is a good distribution medium available to everyone. There is enough venture capital available for the startups to develop their technology and moreover there is no direct correlation between R&D expenditures and growth. In their book (Terwiesch & Ulrich, 2009) illustrate the fact that R&D spending today does not translate to a company’s bottom-line. Apple is enjoying
phenomenal growth with moderate R&D expenses while Dell overspending on R&D for the kind of growth it's enjoying. Acer is growing much faster than for much lowest R&D expenses amongst competitors (Terwiesch & Ulrich, 2009). Innovation today is not confined to secret R&D Labs of an organization. Innovation is happening at the boundaries of systems, amalgamation of multiple disciplines. Good ideas come from collaboration and multiple viewpoints. No one better than the customer can point out to the deficiencies and ideas to improve an existing product. Distributors can help in improving the product delivery and cutting cost in the supply chain, retailers can help in giving ideas for value proposition needed to convince customers. Suppliers understand perhaps better than anyone else what could be capability of a product if it used the latest capabilities of the components they have to offer.

![Open Innovation Model](Figure 4: Open Innovation Model, [Chesbrough 2003])

1.6 The Open Innovation Paradigm

There has been a paradigm shift from the traditional vertical integration model wherein all the R&D activities were internal and the products developed by the firm were result of internal R&D. The work of Professor Eric von Hippel at MIT revolves around research that shows innovation does not simply take place in the halls of research and development labs. Instead, there is an increasing amount of evidence that end users and consumers of products are often
the most prolific innovators, and that they are surprisingly likely to openly share those innovations with others for no cost.


“The use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance the market”

West and Gallagher define open innovation as “systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels.” (West & Gallagher, 2006a)

Therefore, from the above-mentioned definitions, “the open innovation paradigm goes beyond just utilizing external sources of innovation such as customers, rivals, and universities” (von Hippel, 1988). It is a change in the use, management, and employment of the intellectual property (IP) rather than just the generation.

The general idea of open innovation is that a single company cannot innovate in isolation. This is especially true in today’s context when products and systems are getting increasingly complex. Social networks, Social media and online proliferation have vastly democratized the innovation and a new class of user community based product innovation is emerging referred to as “social product innovation” by many. Social product innovation is an extreme democratization of innovation catalyzed by internet and mobile much to the likes of von Hippel (S. Thomke & von Hippel, 2002). Social Product innovation has benefitted the development simple everyday products. Product design at Quirky is a perfect example of community based social product design.

In Open Innovation, firms use both internal and external sources to accelerate the innovation process. In addition to the internal R&D, companies need to get access to external knowledge,
such as universities, startups, direct competitors and other industries to stay competitive in the long run. Many times innovations from other industries give rise to successful products in a totally different industry. For example, the TCP/IP protocol, which was invented for military use led to the worldwide web (internet). The popular joystick gaming interface is also used by BMW as a navigation aid in their BMW 5 and 7 series.

1.7 Open Innovation Vs. closed Innovation

The following table from Henry Chesbrough(H. Chesbrough, 2003) book shows a comparison between open innovation and closed innovation.

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<td>The smart people in the field work for us</td>
<td>We need to work with smart people inside and outside the company</td>
</tr>
<tr>
<td>To profit from R&amp;D, we must discover it, develop it and ship it ourselves.</td>
<td>External R&amp;D can create significant value. Internal R&amp;D is needed to claim some of that value.</td>
</tr>
<tr>
<td>If we discover it ourselves, we will get to the market first.</td>
<td>We don't have to originate the research to profit from it.</td>
</tr>
<tr>
<td>The company that gets the innovation to market will win.</td>
<td>Building a better business model is better than going to the market first.</td>
</tr>
<tr>
<td>If we create the most and best ideas in the industry, we will win.</td>
<td>If we make the best use of internal and external ideas, we will win.</td>
</tr>
<tr>
<td>We should protect our IP, so that others do not get to benefit from it.</td>
<td>We should make profit from our IP and by letting others use it. Also, we acquire or use others IP if it advances our business model.</td>
</tr>
</tbody>
</table>

Table 1: Open Vs. Closed Innovation. Source: Chesbrough, 2003

1.8 Research Questions and Methodology

Companies are increasingly adopting open innovation to benefit from the Internet and the collective wisdom of the crowd. They are using external help for not only idea generation, but over the complete product development cycle: from idea generation to product launch. According to 2012 corporate frost and Sullivan R&D survey (Sullivan, 2012), 30% of the respondents indicated use of open innovation in idea generation. 25% suggested using it in idea screening. 23% employ open innovation in concept testing and development. 8% use
open innovation methods for product launch. The following info graphics summarizes the use of open innovation across the product development cycle.

![Use Of in the Product Development Cycle](image)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea generation</td>
<td>30%</td>
</tr>
<tr>
<td>Idea screening</td>
<td>25%</td>
</tr>
<tr>
<td>Concept testing and development</td>
<td>23%</td>
</tr>
<tr>
<td>Product launch</td>
<td>8%</td>
</tr>
</tbody>
</table>

*Figure 5: Frost and Sullivan survey on Open Innovation (Sullivan, 2012)*

The above graphic suggests that Open innovation is primarily used for idea generation. However, the numbers on the other two phases are also comparable. Companies are increasingly employing external help at every stage of product design to improve their chances of creating a killer product. This thesis attempts to study various case studies and find out commonalities in application and practice of open innovation methods in product design. A list of corporate initiatives in open innovation is studied and taxonomy of open innovation methods is collected and understood from the current academic literature. An attempt is made to find a dominant mode and commonalities in open innovation practices in various phases of product design process.

The rest of the thesis is dedicated on open innovation tools and methods in the present context of digital disruptions and how is it helping companies create new products and services rapidly.

In the next chapter, a taxonomy of current open innovation methods, tools, agents, processes and metrics is developed and discussed.
2 Corporate Open Innovation Initiatives

The following cases of open innovation in industry give enough motivation to explore this topic further and apply it in all phases of product design.

2.1 P&G Connect and Develop Program

Proctor & Gamble (P&G) is a widely known and impressive marketing and brand management company. It has enormous depth and breadth in product technology and innovation. With over 129,000 employees\(^1\) in more than 80 countries, P&G sells in more than 180 different countries and has one of the largest and strongest portfolios of trusted brands. The company holds more than 41,000 active patents worldwide, and is granted, on average, about 3800 new patents each year. Over the past 16 years, P&G has had 132 products on the top 25 Pacesetters list\(^3\), more than their six largest competitors combined. P&G has won many “Product of the Year” recognitions, as voted on by consumers across the globe. (Source P&G public website, accessed January 2013)

In 2004, P&G launched Pringles potato crisps with pictures and words, jokes and trivia printed on each piece. They were an immediate hit. P&G completed the development of Pringles Prints from concept to launch in less than a year and at significantly lower cost. Traditionally, an internal team would have developed the printing technology or partnered with a large inkjet printer company. It’s a difficult investment decision considering the uncertainty of the product succeeding in the marketplace. Instead of approaching inkjet companies, P&G created a technology brief that defined the problem they needed to solve, and circulated it throughout their network of individuals and institutions so seek an existing solution. Eventually, they found the solution in a small bakery in Italy. A university professor who used his own invention to print images on cakes and cookies ran the bakery. This innovation was adapted by P&G and they were able to launch Pringles with prints in quick time and achieved significant revenue growth for the company during the next two years. P&G invested in open innovation and formally launched its Connect+Develop program (Huston & Sakkab, 2006a)

The program is now more than 10 years old and has delivered dozens of super hit products to consumers. Today, the global website receives about 20 submissions per day or about 4000 ideas per year.

In an interview with Harvard Business School, P&G’s former CEO A.G. Lafley describes P&G’s approach to Innovation:\[iv\]. P&G puts the end consumer at the center of all innovation. They engage the end user from the beginning, even at the ideation and prototyping stage. The company co-creates and co-designs with the eventual users, validating and improving the idea at each stage of product design. P&G’s connect + develop program is designed for involving the customers in various phases of P&G’s product design. While the company still pursues the conventional R&D route, Connect and develop program is a great channel to the customer and outside innovators. On the front end, the Connect and Develop website has P&G’s posted needs, organized and searchable by business area. External Innovators can access a full description of every need, size of the market and success criterion and submit their ideas. They can also comment on other’s ideas and give feedback to improve the quality of ideas overall. Feedback is an important method to improve the quality of submissions in an open innovation setting (Girotra et al., 2010).

On the back-end, the site links P&G innovation managers with the idea submissions, letting them search by topic or work area, share internally, and track progress. Tools and processes are necessary for managing the flow of information and proper collaboration. P&G uses video collaboration and telepresence systems for virtual face-to-face meetings.

According to Lafley, the following simple principles can help a company create great products, which can really make a difference in some aspect of the end user’s life.

- Start with the customer.
- Have a simple process for gathering ideas.
- Engage the end consumer immediately with simple concepts and prototypes.
- Work collaboratively. Successful innovation is a team effort. This includes out of the box ways to improve collaboration like shared cafeterias and bathrooms to force interaction between employees.
• Web portal for idea submission and collaboration with innovation partners.

In their paper, Brown et al. describe how P&G tripled their R&D return on investment by making strategic efforts in open innovation over the last decade. (Brown & Anthony, 2011)

2.2 GE Ecomagination Challenge

In 2010, GE announced the Ecomagination Challenge, a crowdsourced global contest that for power grid innovations. With the help of venture capital firms, GE committed up to $200 million to help entrepreneurs develop their ideas and bring them to market. Five winning ideas were selected and $100,000 was offered to each with a possibility to collaborate with GE and its VC partners. 70,000 participants from more than 150 countries, contributed 3,844 ideas through the Ecomagination Challenge website. Also, there were more than 120,000 votes. Along with public voting, subject matter experts evaluated the ideas and adjudged the final winners. Twelve projects were selected to partner with GE and received development funds totaling $55 million (Brightidea, 2010).

The process followed in the challenge was as follows:

• Idea Submission by Individuals or Teams,
• Public and Private Submission Fields
• Voting and Collaboration
• Expert Review and Judgment.

The following tools were used to reduce the transaction costs and information management overhead:

• Integrations with Google Maps and data visualization application
• Mobile Phone app for easy idea submission and feedback.
• Sharing and promoting ideas using Facebook, twitter and YouTube.

For GE, the Ecomagination challenge opened up the viability of new sources of fresh ideas and opportunity to develop commercial relationships.

2.3 Open Innovation at Nokia

Nokia has a history of using open innovation. Originating from a small country and turning
into a multinational giant, Nokia recognized the need of reaching out and look for talent, ideas and capital from outside. One company cannot produce all the good ideas, and it cannot simply have the resources to develop all good ideas and technologies in-house. Acknowledging this fact, Nokia started collaborating with universities around the world including universities in USA, Europe, China, India and Africa to capture the local talent and also understand the different local market trends (Steinbock, 2010). Nokia extensively use social media and the web for collaborating with its users. The key web/social medial supported programs in open innovation are:

- Nokia Beta Labs
- Nokia Pilot Program
- Invent with Nokia Program
- Nokia IdeasProject

![Definition: Crowdsourcing is in the junction of Open innovation and Social Media](image_url)

**Figure 6: Nokia’s Philosophy of User Driven Innovation, Source: Nokia IdeasProject Website, 2012**

### 2.3.1 User Driven testing

Nokia uses its smartphone customers to beta test its smartphone apps before launching it into the market. Beta test website [http://betalabs.nokia.com](http://betalabs.nokia.com) targets a select set of lead users who like to be ahead of the curve in trying futuristic and sometimes wacky apps and ideas. The beta test process helps Nokia to gauge the market for the app and cut costs of development by 1) reducing the testing cost, as well as 2) building in flexibility to kill the project before significantly investing in development and launch.
2.3.2 User Driven Development

Nokia Pilot is a co-creation program complementing Nokia Beta labs. In this program, users can send their ideas and request features. The program involves participation of users from different countries with diverse motivation and interests. The ideas are used in phone prototypes, software, applications or services in development. Few selected participants of the program even get a chance to participate in the real product development. As a Nokia Pilot, users may become an advisor to Nokia development teams around the world and be involved in the design, development and testing phases of concepts, products and services. Nokia even offers outside innovators to patent the idea with together and offers monetary compensation for the same as well through its ‘invent with Nokia’ program www.inventwithnokia.nokia.com.

2.3.3 Ideas Project - crowdsourcing platform by Nokia

IdeasProject is one of the major web based programs supporting open innovation at Nokia. IdeasProject is an online global community of people passionate about creativity and innovation. The online community facilitates the exchange of ideas among mobile enthusiasts, developers, designers, developers and startup incubators.

IdeasProject is founded on philosophy of democratized (user centric) innovation, an idea first conceived and published by Professor Eric von Hippel at MIT (von Hippel, 2005). User-centric innovation offers advantages over the manufacturer-centric innovation. Most of the times, a problem user is solving is not of a scale worthy of manufacturers’ investment on new manufacturing processes and machinery. Users can develop to his exact needs, rather explaining his needs to the manufacturers, which is an imperfect process. Moreover, individual users do not have to reinvent the wheel: they can reuse the existing solutions by other innovator and in-turn share theirs, which leads us to open innovation, another key principle of IdeasProject. The benefit is even greater when partners across the whole mobile ecosystem, like small technology startups, industrial designers, and small app development houses are included.

Through IdeasProject, Nokia has tried to build a community of enthusiastic innovators who are original, constructive, and respectful and who look to build upon other’s ideas and not steal from them. Not all the ideas get monetary compensation and many ideas do not even see
the light of the day. Keeping the users motivated is a key challenge and community development is one of the ways to combat this challenge and sustain the flow of good ideas.

The IdeasProject lists current challenges aligned to company’s product roadmap. A good percentage of challenges are related to smartphone apps and the developers are requested to submit their apps on the company’s website. The apps are developed for either Nokia’s Series 40/60 platform or Windows 8 mobile platform. The winning app gets an award from 1000 – 5000 Euros. The IdeasProject is not only limited to phone apps, but it also has hardware / physical product projects. One of the challenges on the IdeasProject website is to design smartphone covers for the Lumia 820 series phone. In-house development of an accessory is more expensive than the Crowdsourced approach. Moreover, the covers/accessories designed by users is more likely to be a market hit since it already has gone through the multiple iterations, selection and validation phases by community feedback and selection process.
In the past, there have been challenges about industrial design, hardware design, user interface design etc. Some of the ideas are radically new technologies beyond the capabilities and scope of internal R&D. An example for the same is the electronic nose idea submitted by one of the innovators on the IdeasProject website.

![Figure 7: An Idea from Nokia IdeasProject Website, 2012](image)

In one of the earlier IdeasProject challenges, Nokia used crowdsourcing to remake its signature “Nokia tune”. The competition website had around 1.4 million views and 166,674 votes were
cast. Public voting and a panel of judges selected top 10 tunes. This jury then selected the winner and five runner-ups. (Source Nokia website accessed March 2012)

Before being dethroned from the top spot in smartphone market by Apple, Nokia was a pioneer in smartphones. It was the first company to launch smartphone for masses. Much of Nokia’s success can be attributed to its effective innovation strategy that involved open innovation as a major part. In their paper, Dittrich and Duysters studied R&D projects in Nokia from 1985-2002 (Dittrich & Duysters, 2007) to understand their exploitation and exploration strategies (H. Chesbrough, 2003) for innovation and also to understand how their innovation networks and openness helped them to set technology standards and also swiftly change to market conditions. Dittrich and Duysters concluded from their study that Nokia effectively uses an open innovation strategy in the development of new products and services. Nokia used external sources of innovation extensively. The supplier-buyer relationship has been transformed to a networking relationship based on trust and information sharing rather than a formal contract. Results of their study showed hardly any collaboration between 1985-1996. However, between 1997-2002, Nokia collaborated with competing manufacturers like Ericsson and Siemens in order to cope with the disruptive changes in mobile telephony. Nokia created a SyncML initiative in 2000 in collaboration with Ericsson, IBM, Lotus, Matsushita, Motorola, and Openwave. The SyncML is a leading industry standard for universal synchronization of personal information and data remotely across multiple platforms and devices.

Nokia uses virtually every form of open innovation tools and practices in their business. They have a Venture capital company by the name of Nokia Growth Partners. NGP manages a portfolio of promising mobile startups worth $250 million. Nokia is also very aggressive on acquisitions. Between 1998-2010, Nokia acquired 43 companies, which included several networking, multimedia, service companies and Navteq, the mapping service company. In addition to acquisitions, Nokia collaborated with Intel to create a Linux based operating system, Meego. Nokia’s most recent collaboration is with Microsoft in co-developing the windows 8 based smartphones.
2.4 Fiat Mio - create a car

Fiat Mio is a project to build a Crowdsourced car designed using inputs gathered through social media right from the ideation to marketing communication. Fiat launched a website inviting people to submit ideas, and design the world's first Crowdsourced car. The project started in August 2009. More than 17,000 participants from around the world submitted more than 11,000 ideas. Fiat moderators managed the idea generation by stimulating the participants to think on broad theme of a comfortable two-seater urban car that was compact, economical and sustainable. Between January and February of 2010, Fiat’s internal design team collected and interpreted all the ideas from the website, crystallized and documented them in the form of “Making of Fiat Mio Blogs”. Although, the notion of an open source car is that people will design their own car, Fiat controlled the process and Fiat designers decided to be implemented according to Fiat’s design principles and business objectives.

The actual design and development started in April 2010 wherein Fiat designers and engineers started realizing the inputs collected through the website on sketches, CAD and clay models. Design decisions were made and every key decision during various stages of development was communicated online in forms of the “Making of Mio” blogs and video series. Short films were uploaded about the car’s construction. During the design phases, people were able to take part in many decisions like colors, interiors, door configurations etc. For example, three options about the door opening mechanism were posted on the blog and the public was asked to vote for one. Fiat’s designers even let the public into their design center to get direct real-time inputs on prototypes. Before the Mio Project, Fiat Latin America design center was one of the most secret area of the company. Shown below is one of the early sketches and rendering based on inputs from the Mio website.
The car was finally launched officially at the Sao Paulo Auto Show in October 2010. Final specifications for the car are made free for anyone’s use including the competitors, under Creative Commons license.

2.5 Product Design at quirky.com

Quirky is a social product development startup which uses innovative new process of product development which utilizes the power of crowd and cohesiveness of a community to build various consumer products. Quirky was launched in 2009 and since then it has created news by developing innovative products like Pivot Power, shower Station, Stem etc. As on today, Quirky has a community of 393,000 inventors, who developed 321 products and has 288 retail partners. On an average, quirky launches 3 products per week. Figure 9 shows some popular products with their prime inventors and the community team members who participated in the product development. Quirky follows a social sales model wherein it sells its products to the community on their website. Quirky products are also available through its retail partners namely, Target, microcenter, amazon.com, Barnes and noble, best buy, think geek etc. Retail partnership is a very good example of using external channels for selling products. This makes most sense for quirky as it does not have the scale to own a physical retail store. The quirky product design process is a very good example of inbound open innovation (explained in
section 3.3.1 wherein quirky utilizes the existing channels Quirky product design process is described in more detail in section 4.3.2.

![Figure 9. Some Popular community designed products at Quirky (Source www.quirky.com)](image)

**2.5.1 GE-Quirky partnership**

Very recently, Quirky and GE have formed a partnership wherein GE opens thousands of its patents and new technologies to Quirky and its community of inventors for new product development. This is a great example of outbound open innovation wherein a company (GE in this case) opens its inventions to outsiders to be used in their inventions (H. W. Chesbrough & Garman, 2009).

Other than passively sharing the patents and technologies, GE has started a co-branded product development initiative with Quirky to develop smart devices for home in areas of health, security, air and water. This new line of products will be co-branded “Wink: Instantly Connected”.
Combining GE’s technology and scale with Quirky’s collaborative process and speed provides a platform that will truly unlock the applications of GE technologies. Quirky’s out of the box approach will also help find unintended use cases and hence increase the usefulness of the patent or technology in question. Beth Comstock, SVP and chief marketing officer, GE, recognizes Quirky’s speed, collaboration and inventiveness and he thinks that by opening up GE’s technology and patents to everyday inventors will help create new ideas and accelerate innovation.

According to Ben Kaufman, founder and CEO of Quirky, “For years patents have become widely misunderstood and misused. We are going to return patents to their original purpose to act as a blueprint for technological and societal progress while protecting inventors and becoming a source of inspiration for future creators.” (“Quirky + GE,” 2013).

Quirky-GE partnership is a great example of mutually benefiting from sharing innovations and technology and the real intent of patents as “a blueprint for technological and societal progress.”

2.6 Open Innovation at BMW

BMW has a long-standing history of successfully applying open innovation in their new product development. They employ user-centric approach wherein the lead users are involved in idea generation and external innovators are invited to co-develop new products and services.

In 2003, BMW pursued a Customer Innovation Lab program where 1045 users shared their ideas in areas like innovative telematics, infotainment and driver assistance systems of the future. The participants were enabled by a structured multimedia environment to create, view, evaluate and build upon pitches made by other participants.

Customer Innovation Lab generated 215 ideas for various products and services. A few top ideas were selected and further pursued through the stages of concept development and prototyping. Finally, two ideas were realized by BMW and introduced to the market. Since then, different teams within BMW conducted many such independent open innovation projects. In order to synergize the independent efforts by different teams, BMW launched Co-Creation Lab in 2010. The lab is a platform for all co-creation activities throughout the value chain connecting customers, innovators, brand evangelists, lead users and opinion leaders.
According to Gassman et.al. (Enkel, Kausch, & Gassmann, 2005), BMW involves its users in its three-step process for designing a new feature or service. The first step is selecting lead users from the pool of people submitting ideas though their co-creation websites and emails. In the second step, they subject the chosen lead users to an idea or concept to be tested. For example, a new man–machine interface in a future BMW car may be tested with the lead users. In the final step, users from early majority and late majority groups are invited and are confronted with prototypes in order to determine if the prototypes’ design and function are appropriate and whether the final product or service will gain user acceptance. After several iterations of prototyping and user testing, market research is carried out to reduce the risk of failure.
BMW’s Palo Alto Technology Office (PAYTO) in Silicon Valley has the mission to sense market trends and establish contacts with potential external partners (Gassmann & Enkel, 2004a). BMW’s Technology Office in Tokyo gathers trends and application knowledge. Japanese employees act as door openers to the Japanese scientific community and to competing as well as non-competing companies with the aim of tapping their tacit and embedded knowledge.

Other corporate initiatives studied for this thesis are the following. Details of these can be found from their respective websites.

- LeadUsers.nl & Live Simplicity - Philips’ crowdsourcing platforms
- Kraft - innovate with Kraft
- InnovationJam* - IBM’s more internally focused idea generation project
- My Startbucks Idea - shaping the future of Starbucks
3 Taxonomy of Open Innovation

The concept of tapping external resources by companies is not new. Various companies have been using innovations from suppliers and customers. Acquisitions and licensing have been used to acquire a capability or commercialize an innovation. However, the scale of such things happening was small before the advent of Internet. Internet and social media have now made information freely available to everyone and the transaction cost of finding what you need is lower than ever before. There are examples of physical products being rolled out completely from concept to launch with the help of external resources. “Proudly Found Elsewhere” is more and more becoming an antidote to the “Not Invented here” (NIH) syndrome, which has stifled innovation in many big companies.

After Henry Chesbrough coined the term open innovation, there has been a lot of academic interest on this topic. Open innovation now includes customers, suppliers, social media, suppliers, venture investors, and joint development partnerships (Muller, Hutchins, & Pinto, 2012). Figure 11 illustrates different aspects of the umbrella term open innovation.

![Figure 11. Different Aspects of Open Innovation](image)

Hence, it can be seen that open innovation is not just limited to open source or customer inputs. In this chapter, I have tried to scan through a breadth of tools, methods and agents relevant to open innovation and collate taxonomy from different sources. Also, there are quite a few terms used today which relate to open innovation in some way or the other. For example,
crowdsourcing, open innovation, user innovation and co-creation are sometimes used synonymously. The later sections of this chapter will discuss these concepts in detail and will try to bring distinction amongst them.

Figure 12 shows an integrated taxonomy developed throughout this chapter.

### 3.1 Crowdsourcing, Open Innovation, User Innovation and Co-Creation

The term **crowdsourcing** was coined by Howe (Howe, 2006). Crowdsourcing is an open call to the “crowd” on the Internet for solving a problem a company might have. In the present context, the call could be to getting ideas for a new product or even asking for a sub module of a larger product. It could even be soliciting feedback on a prototype or finished design. Howe formally defines crowdsourcing as:

“Crowdsourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined generally large group of people in an open call” (Howe, 2009)

A typical crowdsourcing process comprises of the following steps:

1. Problem Articulation
2. Registration
3. First Submission
4. Feedbacks and Iterations
Today, there are numerous crowdsourcing websites that use crowd participation to generate solutions for their clients. A notable few are Innocentive, Topcoder, and Amazon Mechanical Turk etc. The tasks or problems are delivered in the form of innovation contests or challenges. There is a window of time within which all solution entries are collected and shared on the website for feedback and refinement. Finally, the refined ideas are filtered based on some preset criterions, public voting and expert evaluations. The top idea gates a monetary compensation or recognition. Terwiesch and Ulrich detail such tournament process for problem solving (Terwiesch & Ulrich, 2009). Innocentive has developed a crowdsourced problem solving process called challenge driven innovation (Innocentive, 2012). This process will be described in detail in chapter 4. Amazon Mechanical Turk crowd-sources human intelligence tasks HITs which are very valuable in machine learning research projects, data entry or language transcription. Fiat Mio is a very good example of using the power of crowd to design a product as complex as a concept car. (IdeaConnection, 2010)

**User innovation** or user centric innovation (von Hippel, 2005) refers to innovation done by the end users or the intermediate customers on the products they are using/selling. In his book, Professor Eric von Hippel presents various cases where a product or service was developed or tailored by the users themselves. The scale and scope of the problems were not big enough for the manufacturers to invest their R&D in such new products or product refinements. Eventually, these user innovations are adopted by the manufacturers and the innovations become mainstream in the next generation of products. Since the users are external to the company and the company is using the customer innovations, a user innovation may be categorized as inbound open innovation processes. As also shown in Figure 11, user innovation is a subset of Open Innovation.

**Co-creation** is sometimes confused with crowdsourcing. Both crowdsourcing and co-creation involve collaboration with the crowd. However, in co-creation, a smaller group of individuals with specialize skills manage the whole development (problem solving in general) process and leverages the crowd’s creativity for generating ideas and giving feedback. The crowd may be
selected from a pool of participants. Also, the select group of individuals managing the development can be full time employees of a company or may also be selected from a pool of customers, suppliers, independent designers etc. Quirky.com and P&G Connect and develop programs are examples of co-creation.

Also, there is a distinction between Crowdsourcing and **open source**. Open source is commonly applied to software development. However as per Brabham, open source can also be applied to product development in a general sense. Brabham (Brabham, 2008) describes open source as “allowing access to the essential elements of the product (such as source code for software) to anyone for the purpose of collaborative improvement to the existing product, with continued transparency and free distribution during various stages of open development”. Open source involves collective ownership of the software/product and a community relationship between contributors. There is no monetary compensation to contributors. Self-interest and pursuit of problem solving is a key motivator (Lakhani & Wolf, 2005). On the other hand, crowdsourcing involves an organization-participant relationship and the company running the problem solving contest manages the process top down (Aitamurto, 2011). Also, there is a clear arrangement for compensating the contributors in crowdsourcing. Unlike open source, monetary rewards are a big motivator here.

Aitamurto lays down a conceptual relationship between open source, open innovation, crowdsourcing and co-creation. The following is a modified graphic from Aitamurto’s paper (Aitamurto, 2011). Crowdsourcing will be discussed in greater detail later this chapter.

![Figure 13. Crowdsourcing, Open Innovation, Co-Creation and User Innovation](image-url)
3.2 Inbound and Outbound Open Innovation

In his book Chesbrough (H. Chesbrough, 2003) mentions that open innovation is a two way sharing of innovations: both embracing external innovations and releasing internal innovations to outsiders. Maarten (Munster, 2006) further emphasizes this by categorizing open innovation into inbound and outbound open innovation. As per Munster, Open Innovation is based on two pillars, Inbound innovation and outbound innovation (Munster, 2006). In Inbound innovation, a company seeks external ideas to advance internal innovation projects. Large companies like P&G, Cisco, and Intel are examples using inbound innovation. Whereas in outbound innovation, a company tries to commercialize its innovation by opening it up to the world including its own customers, distributors and competitors. Open source software is a modern example of outbound innovation. Releasing toolkits for the developers is also an example of outbound open innovation. A non-software example is Bush Boake Allen, a company that manufactures flavors and fragrances. BBA used flavor toolkits to make custom flavors for the customers. Customer participation was pivotal for BBA to accurately produce the flavors as per customer’s specification (S. H. Thomke & Nimgade, 2000). Historically, in manufacturing, industry leaders opened up their innovations for the benefit of the industry and also getting benefits from the innovations outsiders did to their manufacturing processes (J. Utterback, 2010).

3.2.1 Inbound Open Innovation

Vertical integration is quite uncommon today. Companies do understand that it’s impossible to do everything in-house profitably and hence the resources are channelized where maximum value can be added and extracted. Typically firms innovate internally on core high value areas of the value chain and acquire technology from external sources for supporting / non-strategic areas. Typically, this ‘make or buy’ decision is not a simple question to be answered. The increasing complexity and interdisciplinary nature of products needs something beyond the typical make or buy dichotomy. Sometimes buying from outside is not a solution and open innovation methods like Joint ventures, technology licensing and co-development are the right things to do. Taking inputs from outside in forms of product ideas, usability feedbacks, standard compliance etc. is another type of openness companies are seeking today. Today, firms scan the external expertise before initiating an internal R&D (H. Chesbrough, 2003). If the required expertise is available outside the firm, it’s used by the firm. Internal R&D either
commercializes the outside innovation or tries to partner with the innovator to jointly develop a product or technology. This is different from the outsourcing method wherein firms typically off load their low value add but critical work to cheaper locations or manpower. Outsourcing is still a closed system where in the outsourcing partner simply acts as a low cost extended team.

### 3.2.2 Outbound Open Innovation

Many times companies open up their technologies for the benefit of the industry and for the long-term benefit of their own self. These companies release internal technological know-how in form of whitepapers, internal design documents, source code etc. without any short-term financial benefit. However, there is indirect long-term benefit in terms of improved technology, faster adoption, market development and eventually more customers. One form of outbound openness is licensing deals. Many platform based products and services exhibit network effects and hence the value of the product or service increase with the number of people subscribed to the service or using the product. It makes sense to open up the platform to third party developers and even competitors and profit from their efforts. In the smartphone world, this practice is quite common. The Platform APIs are released to developers and each app created by the developers increase the value of the phone. By opening iOS APIs to the developers, Apple has created a large install base of iOS apps which increases the value of its iPhone to the users. It also increases the value of the services since an iPhone specific service (e.g. iMessage service locked to iOS platform) has more utility due to more users. Android by Google is another perfect example of outbound open innovation wherein Google gave away its platform to manufacturers for free. Opening up its Android platform has caused mass adoption of smartphones and a large installed base of the android platform. Google now has a stranglehold on 500 Million Android Users and 40 manufacturers. Monetization is possible in many ways and google so far has been very successful in identifying the long-term benefit of outbound openness. If Gillette makes its razor design open to all manufacturers, it will sell more blades. However there is one major challenge involved in licensing. It’s called the disclosure paradox wherein the potential licensee involves some information for free and could in principle steal the idea or technology. Many times the inventors do not reveal their technology or knowledge and this can cause market failure on the extreme. Other challenges may be high transaction costs and assessing the potential value
of the technology. Firms need to think beyond the short-term profitability and be more open for sharing their technology and developing the industry for the longer-term profitability.

3.3 Taxonomy Based on Open Innovation Processes
Based on an empirical database of 124 companies, Gassman and Enkel identified three core open innovation processes (Gassmann & Enkel, 2004):

3.3.1 The outside-in process
The outside in process is about enhancing a company’s knowledge base by acquiring knowledge from customers, suppliers, and other external sources. IBM invests heavily in contact with customers, suppliers and other external knowledge sources. IBM has several industry and university networks which act as a source of external knowledge useful in research projects. IBM’s innovation network also helps it find partners for joint ventures. Cisco invests in young start-up companies to monitor their attractiveness and innovations. Besides evaluating their acquisition potential Cisco also directs the company development towards Cisco standards and Cisco compatible products. The outside in process is not new and companies have been using it for long. Amongst other companies, Gassmann mentions the example of Henkel, DuPont & Bayer integrating customers and suppliers into their R&D activities and having some form of innovation process that helps that integration.

3.3.2 The inside-out process
Inside out process is about reaping the maximum benefit of the created technology by opening it up to the public including competitors. This may include licensing, making a standard or design open or even participating and contributing in a standards development. Commercializing ideas in different industries (cross industry innovation) via the inside-out process in open innovation can increase a company’s revenue immensely by opening up additional revenue channels. The pharmaceutical industry (companies like Norvartis Pharma, Pfizer or Roche) is specifically well known for substances that were initially aimed at one ailment, but became better known or equally successful when used for other ailments. Three examples are Viagra, initially developed to control blood pressure, but became a great success as a sexual aid, Botox, developed as a nerve toxin, but used to reduce wrinkles in beauty therapy (Gassmann & Enkel, 2004). Apple has licensed its Siri voice assistant technology to Chevrolet, Honda and Ferrari, thereby hooking a car and more users to the Apple ecosystem.
This in-turn increases apple’s revenue.

3.3.3 The coupled process

The coupled process takes the best of both processes to gain external knowledge as well as bringing their own ideas to the market. The model for coupled process is to co-operate with other companies and leverage their technology. Gassman quotes an example of BMW iDrive mechanism, which was jointly developed with the local game industry (Gassmann & Enkel, 2004). To support this process, BMW has a dedicated team to identify, explore and develop new ideas. In his paper, Gassman talks about “relational capabilities” as core competency required for building and maintaining relationships with the external partners. Networks and joint venture with other companies can be a key competitive advantage of some companies over others (Gassmann & Enkel, 2004).

Based on their research data in different areas of open innovation, Gassmann and Enkel found that each company chooses one primary process out of the three, but also integrates some elements of the others. These process are summarized in the Figure 14

![Figure 14. Three Archetypes of Open Innovation Process](Source: Gassmann & Enkel, 2004)

3.4 Different Types of Openness

Dahlander et al. further develop the taxonomy by Munster (Munster, 2006) and (Gassmann & Enkel, 2004) by further classifying inbound and outbound innovation. Outbound Innovation is further classified into selling and revealing. Inbound classification is further
classified into sourcing and acquiring (Dahlander & Gann, 2010). Innovation is an economic activity and the ultimate aim for innovation should be to create value for the company. The value created could be directly by selling the innovation or it may be created indirect by sharing and promoting technology or creating an ecosystem that will eventually create more revenue for the company. Dahlander call this direct selling or licensing as outbound innovation selling and the indirect sharing or showcasing as outbound innovation revealing (Dahlander & Gann, 2010). Similarly the inbound innovation is further classified into sourcing and acquiring type based on the direct or indirect benefit extracted. Toolkit approach can be categorized into the “outbound innovation-revealing” bucket. An example of companies practicing “inbound innovation-acquiring” can be Apple and Google.

The table below taken from Dahlander et al. (Dahlander & Gann, 2010), summarizes the different types of openness, with advantages and disadvantages of each.

<table>
<thead>
<tr>
<th>Logic of exchange</th>
<th>Focus</th>
<th>Advantages and disadvantages shaping extent of openness</th>
<th>Disadvantages driving closeness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outbound innovation revealing</td>
<td>Non-pecuniary—indirect benefits</td>
<td>Commercialize products that are on the shelf</td>
<td>Difficult to capture the benefits that accrue</td>
</tr>
<tr>
<td>Outbound innovation selling</td>
<td>Pecuniary—money involved in exchange</td>
<td>Access to a wide array of ideas and knowledge</td>
<td>Over-commitment to own product and technologies make it difficult to out-license</td>
</tr>
<tr>
<td>Inbound innovation sourcing</td>
<td>Non-pecuniary—indirect benefits</td>
<td>Gaining access to resources and knowledge of partners</td>
<td>Many sources create an attention problem</td>
</tr>
<tr>
<td>Inbound innovation acquiring</td>
<td>Pecuniary—money involved in exchange</td>
<td>Acquiring inventions and input to the innovative process through informal and formal relationships</td>
<td>Difficult to maintain a large number of ties with different partners</td>
</tr>
</tbody>
</table>

Figure 15. Different types of openness (Source Dahlander and Gann (Dahlander & Gann, 2010))

3.5 Taxonomy Based on Actors and Organization

3.5.1 Lead Users

The traditional view of manufacturers being the sole creators of innovation in markets is challenged by research that shows that "lead users" are frequently innovating in many markets (von Hippel, 2005). Through research of innovation in several fields, von Hippel found that
many users innovate in diverse ways, ranging from simple customizations to whole product development.

Von Hippel found that the users creating innovation in these categories share a couple of important characteristics (von Hippel, 2005):

1) “They are at the leading edge of an important market trend(s), and so are currently experiencing needs that will later be experienced by many users in that market.

2) They anticipate relatively high benefits from obtaining a solution to their needs, and so may innovate.”

The reasoning for the first point comes from diffusion theory of users and their needs -market needs are not static, and that they change over time. Therefore, the users at the leading edges of market have needs that will eventually be experienced by the remainder of the market. The second is from studies that have shown that the benefit that an entity expects directly impacts the investment that the entity will make towards purchasing or developing a solution(S. Thomke & von Hippel, 2002).

Eric von Hippel describes user’s needs as often being heterogeneous, meaning that it often the case that many users have different needs for a particular product type. This implies that manufacturing firms will have difficulty making the case to produce products that can be suitable for these product types, as they cannot cover the costs of the specialized development. As a result, these users have to make a decision whether they will develop it themselves of have it made by a specialized manufacturer. Since needs are heterogeneous, users with specific needs must decide whether to innovate on their own or to purchase a solution to their specific need. Von Hippel's research shows that transaction costs and information asymmetries affect the likelihood that a lead user will solicit the help of a specialized manufacturer or innovate on their own. Von Hippel identifies the following transaction costs (von Hippel, 2005):

1) Different manufacturers’ and users’ views of a desirable solution to a user need.

2) Different innovation quality signaling requirements between user and manufacturer innovators

3) Different legal requirements placed on manufacturer and user innovators
3.5.2 Innovation Communities

Eric von Hippel describes methods by which lead users work together to create innovations. He defines an "innovation community" as "nodes consisting of individuals or firms interconnected by Information transfers links which may involve face-to-face, electronic, or other communication" (von Hippel, 2005). Innovation communities are familiar in the world of open source software development, where users collaborate in email lists, bug tracking systems and support forums - all while freely revealing their innovations in the form of code patches. The emergence of these innovation communities around open source projects is rooted in the economics of supporting the innovation. In most cases maintaining a patch or innovation to an Open Source product incurs a substantial maintenance cost of patching, building, and redistributing the innovation every time the underlying project changes.

Eric Raymond's related research on Open Source shows the intrinsic value of innovation communities on product quality. In particular, he coined the phrase "with enough eyes all bugs are shallow" (Raymond, 2002). Community responsibility is strong in open source communities, Lakhani and Wolf found that community motivation is one of the top three determinants of hours spent of Open Source project Apache Web Server (Lakhani & Wolf, 2005)

- Enjoyment-related intrinsic motivations in the sense of a form of creativity
- Extrinsic motivations in the form of payment
- Obligation/community-related intrinsic motivations

This implies that a well-created and tended innovation community cannot only draw in innovation; it can also make contributors stay with the community by instilling in them a sense of community responsibility. Community based development is not only limited to software but also to physical products. Threadless.com is a very good example of community based product design. Threadless is a web based t-shirt company that co-creates t-shirts through online competitions. Threadless community is free to join. The membership grants the rights to submit graphic designs and vote on them. There are submission guidelines and templates on the website to help in the submission process. After the submission phase, the design is available for voting for two weeks and the top voted design is selected by the Threadless staff to be printed and made available on sale. The sale is made through the online store. Winning designers typically receive US$1500 in cash and $500 worth of Threadless t-shirts and gift certificates. Threadless enjoys a gross margin of about 30% and has sales upwards of
$30\text{Million}^{\text{xxv}}$. Majority of the customers for Threadless are members of the online community. The Threadless process includes a voting and feedback stage where the community members (customers) pre-validate the designs before manufacturing. Crowdsourcing the design process saves a lot of designer fee and cuts the downside of a new product launch for Threadless.

A cohesive community is the key for contribution. Threadless makes every attempt to create a community wherein there is a free flow of ideas and constructive feedbacks. The website has a lot of blogs and social networking elements to engage the users and facilitate social interactions. Artist stories, media events are published on the websites and people can comment on it. In addition, they have ice cream socials so that the community members can physically meet. The user community is the most valuable resource for Threadless and it is doing all the right things to maintain it.

3.5.3 Crowdsourcers & Crowd

As the name suggests, a Crowdsourcers are businesses that use crowdsourcing to accomplish certain tasks or gather information. On the other side of the crowdsourcing system, there is crowd that contributes in this distributed problem-solving process. In the context of this
taxonomy, Crowd is a group of agents whose motivation to solve a posted problem is monetary reward and/or recognition. The collective intelligence of a crowd is larger than the sum of individual intelligence of the contributors (Lévy, 2006). For this thesis, we will consider crowd as an entity and hence an agent for problem solving, feedback, and even funding and backing up a venture (more description in the crowdsourcing taxonomy).

3.5.4 Suppliers
Very few companies today are vertically integrated to develop and manufacture everything in-house. In fact the premise of open innovation is not to do everything internally but to tap the best from outside whenever possible. Suppliers and components manufacturers play an important role in bringing innovations to the finished end user products. Christensen mentions the role of small specialized component suppliers, dedicated manufacturers and assemblers in bringing innovative enhancements to consumer electronics (J. F. Christensen, Olesen, & Kjær, 2005).

3.5.5 Startups and IP Owners
Large companies routinely acquire startups with disruptive technology or Intellectual property useful to the company’s business. These acquisitions play a significant role in filling up a company’s innovation pipeline. Apple acquired has acquired majority of its technology by acquiring startups. This includes iPod firmware, iPhone multi-touch, camera, maps etc. and also their popular services like iTunes and Siri. The popular YouTube and Google maps are also startups acquired and developed by Google. The above-mentioned products and services are examples of blockbusters not developed in-house but found elsewhere and embraced.

3.5.6 Venture Investors
Venture capitalists play an important role in the democratized innovation ecosystem. New product development is a costly affair and historically, only large corporations could afford the R&D required for new product development. Venture investors (both angels and capitalists) and business plan competitions can provide the necessary capital as well as business advice for the startups and hence promote innovation.

3.6 Taxonomy of Tools and Frameworks
Tools and frameworks used in practicing open innovation are categorized as follows.
Generation Tools

- Design Toolkits
- Social Media and other collaboration tools
- Crowdsourcing
- Crowdfunding

Management Tools

- Web based Innovation Tournaments
- Opportunity Generation Frameworks
  - Ideation
  - Selection
  - Risk Matrices
  - Opportunity Horizons (Strategic Bucketing)
  - RWW Framework
- Social Media analytics

3.6.1 Design Toolkits

Von Hippel describes the concept of a "toolkit" which allows manufacturers to get immediate feedback from these lead users regarding the designs that they would like to create. The goal of the toolkit is to make user innovation both quicker and more inexpensive, potentially increasing the volume of user innovation. The usage of toolkits can help to channel innovation in directions that are most beneficial to the manufacturer. Toolkits solve a big problem of translating user needs into design specifications, which always has been an imperfect process. This reason alone is compelling enough such for the manufacturer to shift the iteration and learning cycle that refines the users need to the user itself. In his lead user theory, von Hippel says that the user knows his needs better than any manufacturer.

Von Hippel gives the example of spreadsheet programs, which are essentially a toolkit used in financial analysis and variety of other design calculations. In the past, a CFO would work with assistants to perform an analysis, refining the work iteratively based on his or her expert knowledge. This would be time consuming and iterative. The introduction of a spreadsheet into the process allows the assistants to instead develop a model in a spreadsheet, which could then be used iteratively by the CFO. This dramatically reduces the time for iteration and produces better results.
Von Hippel gives another example of toolkits from the Integrated circuit industry. In the past, this IC design process was a highly iterative process between the user and the manufacturer, where the prototypes came at high cost and were often insufficient to meet the user's needs. It was noticed that the production of transistors and chips was independent of that was independent of the user's needs, and could be developed without iteration. It was the specific arrangement of transistors and the layout that was different and dependent on the exact user needs. The process was changed and the user was provided with a toolkit wherein the user can create its own design using a high-level design entry method.

Von Hippel describes five fundamental requirements in the development of a toolkit, which are critical to achieving positive results. They are

1. It must enable users to iterate over trial-and-error cycles
2. It must offer a solution space that encompasses designs that users want to create
3. The toolkit should be user friendly and operable with little specialized training
4. It must contain libraries of modules that users can use as building blocks
5. It should ensure that the manufacturer can produce designs without modification

3.6.2 Social Media and Collaboration tools

The following social media and collaboration tools are widely used by startups and independent innovators to find and share information and collaborate across the globe.

- Search Engines
- Online databases, free patent databases
- Social Networks
- YouTube and Podcasts
- Wikis and shared online workspaces
- Social Media
- Online problem solving tournaments

3.6.3 Opportunity Generation Framework

In their book, Innovation Tournaments, (Terwiesch & Ulrich, 2009) describe a process of product planning involving internal and external sources including R&D, Customers, Suppliers, manufacturing, universities and other sources. They describe the product design process in three generic stages.
Ideation is the most important phase of all. A good concept coming out of the selection phase would be as good as the best concept in ideation. Finally a final product will be no good is the selected concept was average.

In a closed innovation paradigm, ideation was limited to marketing and research personnel, which surveyed current and potential customers for their needs and then consulted their product teams for possible solutions. Few companies reached out to suppliers and outside inventors and licensed technologies at the most. But when it came to the market need and product ideas, it was all within the sales, marketing and the engineering teams.

Terwiesch & Ulrich emphasize the importance of sensing the opportunities (Terwiesch & Ulrich, 2009) than simply creating them internally.

Figure 17. Figure adapted from Innovation Tournaments (Terwiesch & Ulrich, 2009), and Product Design and Development (Ulrich & Eppinger, 2008)
Concept selection is the next critical element in opportunity generation. Selection is easy once we have decided on the Selection criterion. Selection criterion is mostly derived from the product design constraints, customer requirements etc. The opportunities may also be screened based on risk benefit analysis; namely gross margin potential, novelty, development risk and IP protection.

Public voting is an inexpensive method for a first level selection. Social media can be a cheap web based platform, to automate the public voting and vote analysis process.

The key decisions a manager needs to make in this phase are

- The final number of concepts to be selected for implementation: one, two or many.
- Balancing efficiency Vs. accuracy of selection

There are other methods for opportunity selection which are described in sections 3.6.4, 3.6.5 and 3.6.6.

3.6.4 Innovation Return Curve

Terwiesch and Ulrich (Terwiesch & Ulrich, 2009) explain the concept of innovation return curve as an excellent tool for the managers to select exceptional opportunities and hence improve the overall return for a given investment of resources. An innovation return curve is a plot between profitability indices of projects (ratio of the revenues to the cost) vs. cumulative investment on the projects this curve provides a clear picture if resources being wasted in fringe opportunities. With the help of the innovation return curve, the authors show that higher R&D Budget does not necessarily correspond to better financial performance. I think this is one of the key lessons from the book: Selection of right opportunities is more important than just increasing R&D budgets and funding marginal opportunities.
3.6.5 Strategic Bucket Method for Opportunity Selection

In their book Innovation Tournaments, (Terwiesch & Ulrich, 2009) define a strategic framework called “Strategic Bucket Method” to categorize the opportunities into “opportunity horizons” and define an “innovation frontier”, a boundary for segregating opportunities to pursue from opportunities which don’t align to the organization’s competencies, risk averseness and innovation strategy. The two dimensions of technological and market knowledge and uncertainty are unified into a single perspective of opportunity horizons. Often, managers are faced with a mix of opportunities representing different levels of technology and market uncertainties. Essentially it’s a choice between putting the resources in different strategic buckets and if we analyze closely, horizon1 opportunities are nothing but much familiar “incremental innovations” while horizon3 are the uncertain opportunities for radical innovations. Regardless of the terminology, I think this framework is very useful not only in designing innovation tournaments, but also in filling the innovation pipeline with right portfolio of opportunities for maximum return on investment. Not to mention that innovation return curve is an excellent supplementary tool to prioritize amongst the filtered set of opportunities. A balance between “exploitation” of current technology and markets and “exploration” of new ones are the key to sustenance in these uncertain times. Although
authors don’t have a prescription for the “right mix” of exploitation vs. exploration
nevertheless they have been able to ask the right questions and have provided enough tools
and frameworks for the managers to make good decisions.

Figure 19. Opportunity Horizon Analysis of generated opportunities at Analog Devices (Source: Analog Devices, 2012)

3.6.6 Risk Analysis for Opportunity Portfolios

Similar to the opportunity horizons analysis, Risk analysis along with the profitability (size of
the bubble) can be used to choose a proper mix of high or low risk opportunities. Figure 20
shows a risk analysis chart for an opportunity generation exercise at Analog Devices, a
semiconductor design and manufacturing company. The risk analysis framework is borrowed
from (Day, 2007) and modified to represent profitability of the idea along with the market and
technology risk they pose. The Size of the bubble is proportional to the expected return on
investment. The position of the bubble depends on the aggregate probability of failure of the
innovation. The market and technology uncertainty can be evaluated by a set of questions
related to the technology used and the market need it is serving.
Figure 20. Risk Analysis of Generated Opportunities at Analog Devices (Source: Analog Devices, 2012)
3.7 Integrated Taxonomy

The following figure summarizes the taxonomy of open innovation collected from various literature sources described in this chapter. The taxonomy is generated by collating different concepts from the academic literature, related to open innovation. This taxonomy is by no means a comprehensive one, but it is a good starting point and a unified reference helpful to managers in adopting an open innovation strategy.

![Integrated Taxonomy of Open Innovation](image_url)

*Figure 21. Integrated Taxonomy of Open Innovation*
4 Open innovation applied to product design

According to Ulrich and Eppinger, a product is “something sold by an enterprise to its customers” (Ulrich & Eppinger, 2008)

A process is a sequence of steps that transforms a set of inputs into a set of outputs. Combining the two definitions, a product design process will be a set of steps that transforms a concept into a sellable product.

In their book, Ulrich and Eppinger define product design process as:

“The set of activities beginning with perception of the market opportunity and ending in production, sale and delivery of a product “

Many variations of a product design process exist specific to an industry or an enterprise. Some firms follow a process religiously while some do not have it formalized. Sometimes, a single firm employs slightly different process for different products. A well-defined process is useful for planning and coordination purpose. A process also reduces uncertainty, brings in quality control, repeatability and improvements in the product.

4.1 A review of Product Design Process

There are lot of variations and different names of product design process followed in different industries. However, all of them follow some sort of stage-gated approach with checkpoints and sometimes iterations with information from one stage feeding into another and vices versa. Eppinger & Ulrich describe a generic product development process in their book which consists of the following six phases(Ulrich & Eppinger, 2008):

1. Planning
2. Concept Development
3. System Level Design
4. Detailed Design
5. Testing and Refinement
6. Production Ramp up

Figure 22 pictorially depicts the generic flow.
Figure 22. Generic Product Development Process

Before starting the product planning, and detailed design, it’s important to select the right idea or the market opportunity. Ulrich & Terwiesch describe a framework for opportunity generation and selection (Terwiesch & Ulrich, 2009) in their book. The framework is described in the later sections of this thesis.

Table 2 is adapted from (Ulrich & Eppinger, 2008) and summarizes the generic product development process with tasks and responsibilities mapped to key functions within an organization. A little modification has been made in a few sections of this table.
4.2 A few variants of product design processes used in industry

4.2.1 Spiral Product Design Process

A spiral process is characterized by many iteration cycles in detailed design phase. The detailed design phase is split into a minimum viable product followed by implementation and testing. A minimum viable product (MVP) is self-sufficient in terms of the functionality it offers and is test worthy for the customer. Sometimes the MVP is even launched to the customer while the company adds features to it in a design-build-test fashion(Moogk & Carolan, 2012).
This type of process is more common in modern software design. However, a few startups are actively combining the crowdsourcing and spiral design in physical products to bring down the development cost and time to market. Quirky, OpenIDEO and Threadless.com are few examples, which actively employ a community of users and developers to iterate through various product revisions. The design, test and consumption, all happens in the community. The spiral PD process is very well suited for products where market needs are dynamic or not very well understood. It not only applies beautifully to software but also to quick-build product and services(Ulrich & Eppinger, 2008). In my opinion, a spiral design process may be better suited for technology push type product wherein the market uncertainty is more than the technical uncertainty. These iterations help to test out the product thereby reduce uncertainties and increase the expected payoff from the development. These planned iterations facilitate changes and improvements in the product. These iterations also builds flexibility (Wang & Neufville, 2005) in the design in terms of options to close or expand the project at any time thus minimizing the downsides while cashing on the upsides. Ideally by process design, the iterations should not be long and should not feed back to the planning and concept development stage.
4.2.2 Complex System Product Design

In a complex system product development like jet engines and automobiles, the simple sequential set of activities is not sufficient. In fact the system architecture, project plan, resources and organization structure influence a complex product development flow. The detailed design stage is broken down into tasks and the tasks are sequenced. The tasks are mapped to resources and accordingly a series / parallel hybrid process is designed. Each set of subtasks could have multiple iterations between design and test. Each phase is followed by a phase gate where a set of current system / design parameters are measured against targets set for that particular phase. If targets or goals of that phase are met, the design proceeds to the next phase, else it remains in the previous phase or the project is abandoned.

![Figure 24. Modified Complex Product Design Process, Source (Ulrich & Eppinger, 2008)](image)

4.3 Open Product Design Process

An open product design process can be defined as a product design process, which involves external actors like customers, external innovators, suppliers and the crowd\(^2\). Many companies today integrate their customers, suppliers and outside innovators in their innovation process. Involving the end user is essential especially for disruptive products to generate demand as well as to guarantee that the product is actually meeting some unmet need. Conventionally, companies used expensive methods like focus groups, interviews and surveys. Now, with the advent of social media, customers can be integrated in to the product design process.

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\(^2\) As in Crowdsourcing
economically and effectively at all the stages of development. The lower transaction cost of social media and community engagement aspect ensures better customer participation resulting in statistically significant and timely inputs during the design process. In their book, Li and Bernoff, propose strategies for companies to use social networks for sensing “groundswell” market trends (Li & Bernoff, 2011). Most companies today, use social media in their marketing functions. Some companies like Nokia and P&G have even accommodated social media in their product development process to interact with customers and outside innovators.

4.3.1 Social Network Driven Innovation

In his paper, Degen describes a generic eight step social network driven process, appropriate variations of which, companies use for product design (Degen, 2009).

![Figure 25. Social Network Driven Innovation Process, Source (Degen, 2009)]
It can be seen from Figure 25, that every step of the process is a social interaction between different external (outside the core design team) collaborators followed by analytical work by the product development team. There is an aspect of freeform plus controlled process, where every “cloud” step is a freeform open social interaction between customers, non-customers, product reviewers, technology enthusiasts etc. Every rectangle represents a more closed interaction within the product development team.

Interesting parallels can be drawn between the product design process described by Ulrich and Eppinger in section 4.2. There are ideation, concept testing, detailed design and manufacturing/commercialization phases similar to those described in section 4.2. Also, there are iterations with outputs of a phase feeding back into some of the previous phases. The social aspect and feedback at every phase is unconventional and different than the process described in section 4.2. According to Degen, although the steps mentioned are in an orderly sequence, the process need not always be in that strict order. In many cases, insights gathered by the analysis steps shorten the process by bypassing some of the steps. For example, during the concept testing phase, the product development team may find out that the developed concept does not serve a compelling need and hence the idea is dropped and the process loops back to idea generation.

**4.3.2 Community Based Product Design at Quirky (Co-Creation)**

Figure 26 shows a product development flow at Quirky.com, a social product development startup. Quirky is a very good example of community-based co-creation (refer to taxonomy section 3.1). The user community performs majority of the process steps.

![Figure 26: Social Product Development at Quirky.com (Source: Quirky.com)](image)

Figure 27 shows a more detailed view of the social product development at Quirky. It can be seen that community plays a major role in all the development phases except product evaluation, engineering, manufacturing and sales.
4.4 Using Open Innovation in Product Design

4.4.1 Product Planning
A product planning process precedes any formal commitment to a particular product development process. Planning is done before employing substantial resources and a development team. Product planning is an activity that considers broad level organization goals and market strategy in addition to development cost and time to market.

In general, product planning takes care of the following things for the company:

- Product Portfolio, platforms and derivatives
- Product roadmap
• Project plans and product development program

A product that qualifies the selection criterion finds a place on the product roadmap and is assigned to a development team that needs to create a mission statement for the team to guide the product development process.

• Scope, timeframe and budget of the project
• New technologies to be incorporated (if any)
• Market segments (Low end, mid end or high end)
• Manufacturing constraints
• Service processes and goals
• Financial Targets

A typical Product planning process comprises of the following steps:

1. Identifying Opportunities
2. Evaluating Opportunities
3. Allocating Resources, planning budget and schedule
4. Complete the pre planning activities.

In his book, Innovation Tournaments, (Terwiesch & Ulrich, 2009) describe a process of product planning involving internal and external sources including R&D, Customers, Suppliers, manufacturing, universities and other sources. They describe the product design process in three generic stages.

• Ideation
• Selection
• Implementation

Ideation is the most important phase of all. A good concept coming out of the selection phase would be as good as the best concept in ideation. Finally a final product will be no good is the selected concept was average.

In a closed innovation paradigm, ideation was limited to marketing and research personnel, which surveyed current and potential customers for their needs and then consulted their product teams for possible solutions. Few companies reached out to suppliers and outside inventors and licensed technologies at the most. But when it came to the market need and product ideas, it was all within the sales, marketing and the engineering teams.
Terwiesch & Ulrich emphasize the importance of sensing the opportunities (Terwiesch & Ulrich, 2009) than simply creating them internally. They cite the example of Red Bull which was not developed by Dietrich Mateschitz but he simply found it on one of his trips to Thailand. Red Bull now competes with beverage industry giants like Coca Cola and PepsiCo which spend hundreds of millions on R&D. The authors prescribe the need of sensing opportunities from customers, suppliers, universities and companies in distant geographic regions. They present a very comprehensive list of places to sense for opportunities:

- Geographically Isolated Innovations
- Small Companies with Niche Products.
- Identify Lead Users
- Independent Inventors
- Universities
- Scanning of communication channels like blogs, journals etc.
- Social Networks
- Innovation Contests from Innocentive and other Crowdsourced open innovation platforms.

Product design companies today should actively pursue social media as a source of ideas. The ubiquitous internet and mobile has made social media hugely popular. People are finding many ways to use and monetize social media and idea generation is one of them. In fact majority of big product companies have their own pages on social networks and blogs where they solicit user data for their market research and user inputs for product ideas. A few companies even have a structured ideation platform where they invite users to join and give ideas and
participate in the design process. A very successful example is P&G Connect and Develop Program and its idea factory.

4.4.1.1 Generating and Sensing Opportunities

This is the stage wherein opportunities are identified for innovation. An opportunity may already exist for a known problem at hand or an opportunity might be created for an already existing solution or product. A key step in the ideation phase is exploration of the problem space, defining and constraining the problem. Constraining the problem limits the solution space and makes the solution search less costly. The chances of a discovering high return opportunity in a constrained solution space depend on the number as well as diversity of ideas we generate in the ideation phase. The more ideas we have, more are the chances for finding a good idea. The more eccentricity we allow for generating the ideas, better are chances to get something exceptional, different from the league of common solutions.

The idea of maximizing the opportunities is straightforward. However, it’s very costly to generate large number of ideas with high quality variance in Conventional R&D hierarchy prevalent in most companies. We have teams working in isolation wherein the designers conceive a solution, implementers implement it and testers do the testing. These silos and demarcated responsibilities limit the diversity and quantity of solutions. Consequently we end up spending our implementation resources on a mediocre opportunity.

From a purely probabilistic viewpoint, innovations are draws from a payoff distribution. Exceptional innovations are low probability events and the expected returns follow a tail distribution with a peak and long tail. If we as managers can somehow shift the peak of the distribution curve towards right, we have increased our expected revenues by having more opportunities for selection. More opportunities for selection gives one more chances of hitting an exceptional opportunity.

As a manager, one can think of using the following levers to generate more solutions in hope for finding the best one.

- Time to invest on ideation phase searching for opportunities
- Balancing the flat vs. Hierarchical organization in ideation.
- Managing the sources of innovation: Internal Vs. External
Design firms like IDEO are very good in idea generation. They follow a flat hierarchy with no clearly demarcated roles especially when it comes to participation in an ideation brainstorming. As a result, they are able to produce marvelous innovations internally in almost every application area on a consistent basis.

Certain firms use the toolkit approach to increase the number of innovators (External source of innovation) at the ideation stage in terms of both quality and the number of ideas. Innocentive.com has already created large value for itself by creating giving companies an exposure to sheer quantity and diversity of ideas.

4.4.1.2 Selection

Concept selection is the next critical element in managing innovation. Selection is easy once we have decided on the Selection criterion. Selection criterion is mostly derived from the product design constraints, customer requirements etc. The opportunities may also be screened based on risk benefit analysis; namely gross margin potential, novelty, development risk and IP protection.

The key decisions a manager needs to make in this phase are

- The final number of concepts to be selected for implementation: one, two or many.
- Balancing efficiency versus accuracy of selection

The final number of concept to be selected is based on the risk mitigation strategy of the developing firm. Selecting more number of diverse concepts (low accuracy of selection) for implementation hedges the risk against one common mode failure. At the same time they increase the implementation cost, and also warrants an additional selection step after implementation wherein we have to choose one product for the final product launch. On the other hand, selecting just one concept (high accuracy) requires more effort (low efficiency) in the selection phase and lesser effort in implementation phase. However one has to be more thorough in concept selection by having a multi stage elimination process. It may be noted that the review cost per concept to be screened increases with the increase in number of stages as it is more difficult to select between two very closely competing concepts. A low efficiency selection process is costly and high accuracy selection process can sometimes prove wasteful. The tension between efficiency of selection vs. the accuracy is evident here and a manager
needs to make a decision to resolve this by carefully planning the number of screening iterations and trading off between efficiency and accuracy. West et al. discuss the problem of higher coordination costs and risks in using external innovations as compared to internal innovations (West & Gallagher, 2006b). The co-ordination problem is compounded by the orders of magnitude larger number of ideas / information generated. Basic graph theory would suggest that, for large n, the coordination cost amongst the n elements of an entity E is proportional to $n^2$, assuming each element can talk to other element.

Multi-voting process, broad organizational product strategy and risk appetite are some of the guiding tools that can be used by the product development team for making fast and efficient selection. Below is a chart from an opportunity generation project at Analog Devices in summer 2012, wherein market and technology risk was used to plot the generated ideas on an XY plane and then risk zones were characterized. A proper mix of horizon 1, horizon 2 and horizon 3 opportunities were selected for the product portfolio. A total of 180 opportunities were first filtered by multi voting to 45 opportunities. Those 45 opportunities were then plotted on a risk matrix and opportunity horizon matrix and put into strategic buckets of black swans and cash cows.
Figure 29: Strategic Bucketing of opportunities at Analog Devices (Source: Analog Devices, 2012)

Terwiesch and Ulrich also suggest selection of ideas based on competitive strategy, market segmentation, opportunity horizons, technology trajectories and product platforms (Terwiesch & Ulrich, 2009).

Another framework for selection from large number of opportunities can be borrowed from Clay Christensen’s paper. In his paper, Christensen describes a framework for organizations to cope with the disruptive innovations in the market. (Christensen, & Overdorf, 2000). Firms to assess their readiness and willingness to execute a strategy, for pursuing an idea, can also use the same framework. On the other hand, they can decide not to play in the unknown turf and abandon the idea by using this framework.
In zone A, the project fits with the company’s processes and core values, so no new capabilities are required. A functional team can handle the project no changes in the organizational structure. In zone B, the project aligns well with the company’s values but not with its processes. New types of interactions and coordination among groups and individuals is required for this type of innovation and hence a cross-functional team is more suitable, but the project can be executed within the company. In zone C, the product is a disruptive change and it doesn’t fit the organization’s existing processes or core values. In this case, inside-out innovation processes may be used to spin-off organization and commission a cross-functional development team to handle the challenge. The spinout will allow the project to be governed by different values and a different cost structure. In zone D, the innovation fits the organization’s current processes but doesn’t fit its values, the key to success almost always lies in commissioning a cross-functional development team in a spin-off company. Development may occasionally happen successfully in-house, but successful commercialization will require a spinout (C. M. Christensen & Overdorf, 2000).

There are other planning tools that can be used. They are described in section 3.6.
4.4.1.3 Allocate Resources and Plan timing

It is not likely that all the selected ideas may find a place in the product roadmap. Timing of a project is also important and hence many projects may compete for limited resources. Typically some form of tournament structure (Terwiesch & Ulrich, 2009) is used for generating ideas filtering them. The high number of generated ideas can be challenging in an open innovation setting and there could be a number of external stakeholders involved. The management of stakeholders for a co-development is a complicated task and should be meticulously dealt with. After selecting a promising product opportunity it’s important to think about the costs, timing and integration into the product roadmap. Platform strategy (Muffatto & Roveda, 2000) also determines which projects will find place in the roadmap.

Christensen suggests a framework (see Figure 30) that can help managers build and organizational structure and allocate the right team (C. M. Christensen & Overdorp, 2000). The 2x2 framework has a vertical axis asks the manager to measure the extent to which the product idea is aligned to existing processes within the organization. The horizontal axis is an assessment of the organization’s values will aligned to the product idea in order to allocate the resources.

The steps in product planning process are cost elements. At the same time they are very strategic to company’s business success and must be very tightly tied with the core values of the company and also make the most efficient resource usage. Open innovation can be advantageous in saving some costs in the planning process at the expanse of diluting the strategy. It has to be understood that involving outsiders in the design process reduces direct costs but adds overheads and transaction costs. Managers have to be aware of the tradeoffs and the indirect costs. There are a few exceptions in the low-tech products, which use their customers in the planning process. Below is an example from Black & Decker, which used outside sources in design to a drill machine. It used a decision making process and a software tool from a company called Decision Lens. The complete case study is described in the forthcoming sections of this thesis.
4.4.1.4 Accelerating Time to Revenue Generation at CISCO

The Cisco Enterprise Collaboration Platform Business Unit is a cross-functional development group that includes team members from product management, engineering, quality assurance, user experience, program management, and their executive sponsors. This team used an internal social platform to create a collaborative community and integrate their work processes and achieve rapid product iterations. The use of the social platform resulted in 12% productivity gain per employee and the team delivered the project in 12 months.

There are lots of social planning tools already existing and are actively developed which can leverage the social media with business. By actively marrying social plans with local businesses, there is an opportunity to enhance time to market and also to increase revenue and branding opportunities for businesses, due to the better knowledge of the customer.

4.4.2 Product Goals and the mission Statement

In this phase, the product team collaborates with different internal and external stakeholders to define the key business goals and mission statement for the product. Ulrich and Eppinger (Ulrich & Eppinger, 2008) emphasize the importance of product planning and mission statement as a key step in “pre-project planning”. A mission statement may include some information about the description of product, the value proposition, stakeholders and key business goals. Conventionally, the mission statement is internally focused and can be efficiently done internally without overheads and dilution of business goals. Out of the companies studied for this thesis, none used external sources for the mission statement or the product objective. It was typically done internally within the marketing and internal R&D Teams. Therefore, the case studies suggest a common practice of keeping this activity internal rather than opening it up to the external world, which would simply create confusion increase planning costs. Product goals and mission statements are instead used as seeds or stimulus for the idea generation and concept development process. Terwiesch and Ulrich talk about an emergency stimulus to stimulate idea generation (Terwiesch & Ulrich, 2009). The stimulus sheet can be derived from the mission statement and product goals.
4.4.3 Identifying User needs

Ulrich and Eppinger present a five-step process for comprehensively identifying and characterizing a set of customer needs (Ulrich & Eppinger, 2008). This is a general process for an established product that considers consumers as final beneficiaries.

The process assumes that the list of all stakeholders affected by the product’s success or failure has already been done during the planning phase of the product. That list serves as a reminder for the development team to consider the needs of everyone who will be influenced by the product.

The five referenced steps proposed to identify customer needs are:

i. **Gather raw data from customers:**
   
   Gathering data involves contact with customers (interviews, focus groups) and experience with the use environment of the product (observing the product in use). This process entails an exploration of both market and customer variety. The collection of data may involve gathering information about needs from different segments, and articulating emerging needs, inadequacies of existing products, or latent needs for the majority of the market.

ii. **Interpret the raw data in terms of customer needs**
   
   The next step is to interpret the needs underlying the raw data and translating them into written statements. The two more important guidelines for an effective translation are:
   - Express the need in what the product has to do, not in terms of how it might do it.
   - Avoid loss of information by expressing the need in the same level of detail as the raw data.

iii. **Organize the needs into a hierarchy of needs**
   
   The goal of this step is to organize the statements of needs into a hierarchical list. According to Ulrich and Eppinger, the list will typically consist of a set of primary needs; each of one will be further characterized by a set of secondary needs. In cases of very complex products, the secondary needs may be broken down into tertiary needs as well.

iv. **Establish the relative importance of the needs.**
This step establishes the relative importance that customers place on the different needs in order to guide the task of resource allocation in designing the product. There are two general approaches to this task:

- Relying on the team experience with customers.
- Base the importance assessment on customer surveys.

v. Reflect on the results and the process.
Finally, the team must challenge its results in order to verify consistency with the knowledge and intuition the team has developed through interactions with customers.

4.4.3.1 User Needs at Quirky
Quirky employs crowdsourcing for creating very rudimentary product ideas and then use the same user community for evaluating and refining the ideas. Individuals suggest different features, designs and then even the product name and marketing slogans. Then, if enough people look like they actually want to buy the product, Quirky manufactures and sells it. Thus, the users define their own needs and also validate the existence of the market.

4.4.3.2 User Needs at Diamond Candles
Instead of relying on traditional market research, Diamond Candles crowdsources idea submission and uses its existing customers to vote and select the best ideas. The company then takes the top 10% of voter suggestions and cross-references them with market trends to decide the new scents to launch. They get real time analysis of which future candles customers would be most likely to favor and accordingly change their production schedule. In the first month of inception, their idea generation program received more than 250 new product ideas and 5,000 customer votes.

4.4.3.3 Market Testing the User needs at Zynga
Zynga has a six-step process for market testing their game ideas even before writing a single line of code. Here is the process on the words of

- Create a 5-word pitch for a new product or feature
- Put it up on a high traffic webpage
- If it gets clicks, collect the emails of interested customers
- Build a ‘ghetto’ version of the feature
- Test everything
- Iterate constantly

4.4.4 Product Specification

Conventionally, in hi tech and complex product design, specifications are done internally because of the details and complexity involved. Organizing for innovative product development is challenging and many times a manager has to co-locate the team to reduce the communication and coordination costs (Allen, 2001). Even a good architecture for complex product may have multiple levels of system hierarchy with 5 to 9 components at each level. Detailed design of such product involves iterations between component design teams and flow of information for making key design decisions and cutting down the iterations are important. Therefore, for cost, quality and management reasons it may be beneficial to keep this activity internal to the design team. Ulrich and Terwiesch give a framework, which can be indirectly used to decide if involving outsiders will be useful, especially in a complex product (Terwiesch & Ulrich, 2009).

Figure 31: Framework for deciding the extent of outside involvement. (Terwiesch & Ulrich, 2009)

Products with low required skills and are more suited for involving customers.
4.4.4.1 Users develop Specifications at VitaminWater
For a beverage product, everything including the color, transparency, flavor, packaging and name is part of the specification. Vitamin Water’s flavor “Connect” was developed by the company’s Facebook fan base; one Facebook fan won $5,000 for her role in development of the new flavor. The competition allowed VitaminWater’s Facebook fans to develop all aspects of the product, from selecting the flavor to designing the packaging and naming the product.

4.4.4.2 Crowdsourced Spec development at Quirky
Quirky actively involves the users in feedback process for bringing the product concept to the actual user need and also translating the needs into the specifications.

4.4.5 Concept Testing
The importance of product testing cannot be undermined. The principle of failing often and failing early is golden in almost all product design books, including the classic text by Ulrich and Eppinger (Ulrich & Eppinger, 1995). Eppinger emphasizes on the importance of prototype in ironing out product defects and falsifying wrong assumptions. Prototyping is a form of testing which comes during concept development and pre manufacturing stages. When you prototype you have already committed to some form of the product concept and have incurred a sizeable cost in the product design effort. Product testing is also done with focus groups wherein they are given looks-like-works-like and alpha prototypes to use and evaluate. However, the alpha prototype is pretty much the final stage of the product design and significant investment has been made into the product by that time.

4.4.5.1 Concept Testing at IDEO
Tom Hulme, Design Director at IDEO believes that the feedback from the focus group is rarely representative of the real world. It’s a test in ideal conditions and the results may differ as compared to a real use case in the target market. Also, a focus group should be carefully selected and should not only represent the lead users and early adopters. The real market for any product is early majority and late majority of adopters (Rogers, 1995).

IDEO has a new approach to testing wherein it skips the focus groups and uses some of the open innovation methods for testing the product even before you have a prototype(Hulme, 2012).
4.4.5.2 Public Prototyping and Testing
Hulme (Hulme, 2012) gives the following recipe for testing an idea or before making a significant investment in making a product out of it. He recommends putting out the idea in the open to see if it survives. Prototypes help but most prototypes are built and tested in a closed ideal setting. Many times a validated prototype sees market failure after the company commits to production and launch. Hulme believes in “failing early and failing cheap” and he proposes a few Internet based open methods for testing.

- **Skip the Focus Group. Place your product or service in a real market.**
  - V Water when launched its drink, put the prototype on the retail shelf and observed real customers if they picked it up from the shelf. By doing this V Water got real time feedback without using a focus group (“PepsiCo acquires UK vitamin water brand - V Water, PepsiCo UK,” 2009.).

- **Test the appeal of the product online for a larger market** – While V Water’s approach may not scale easily for products for mass markets, new technologies enable us to see if our idea appeals to a specific group or even mass markets. Companies like Zynga test a game idea by putting a 5 words pitch on a popular website and then redirect the users to a survey. Hence it can assess the interest and minimize the chance of market rejection even before writing a single line of code. Zynga’s CEO Mark Pincus refers this as Ghetto Testing (Gratt, n.d.).

- **Launch a mock version of your product or service to see if it serves a need** – Intuit; an accounting company went beyond testing the marketing appeal. Intuit wanted to test if a new SMS service for Indian farmers will actually be adapted. Instead of developing a full-fledged version, the team developed a convincing mockup and fulfilled the complex part of the system themselves. By launching the mockup Intuit validated the real need and was also able to incorporate the feedback from the mockup into an actual product. This is in some way a minimum viable product. temperature@lert uses mockup websites to gauge customer interest up to a point where customer puts an item in the cart but cannot make the purchase. This is a quick and easy way to know the actual purchase intent and forecast the expected demand for the product.
Public prototype can feel risky and you may be worried that the idea can be copied or you may embarrass yourself by launching something less than perfect. However, there are risks associated with any product launch. Public prototyping has advantages in terms of

- Faster
- Lower cost
- Less risky than placing a big bet on something customers may not want.

According to A.G. Lafley, Former CEO of P&G, involving customers at the very early stages of prototyping is the key to developing breakthrough products. Public prototyping works beautifully for P&G in continually assessing and understanding the customer’s need and wants. Additionally it motivates the development team, as they know at all the times that they are developing real products, which will change some aspect of their customer’s life. Public prototyping is another way to think about the customer all the time, even at the design and evolution of the product, which has typically been a closed and internally focused process. Involving customers at an early prototyping stage also increases the expected ROI of the development project, since it builds in flexibility to close the project at any time and cut the potential downside. The flipside though could be tarnishing of the company’s image or brand if a mal-functional prototype is given to the customer. Care should be taken to choose a select group of users and release a prototype with a set of minimal core features that work reliably. Each subsequent prototype release can come with additional functionality, making the product more complete. For example, one can start with a looks like sketch, scale or life size model with the materials and form resembling the intended final product. “Looks like” models are great way to communicate the intention of the product and get feedback even before implementing a single functionality. Concept car is a great example of showcasing a design to the public before even the technology is mature to support the design. The concept of minimum viable product is very popular in software products wherein core functionality is released as beta software to select users and functionality is added with each subsequent release, fixing bugs and modifying the user interface etc. at the same time. The practice is prevalent in physical product design as well wherein Suppliers give their development versions of the component to the OEMs (customers) and the OEMs experiment with the components and design their own system while the more improved components are available. In the process, the supplier gets continuous feedback for improving the product and fixing bug, while continuing with its own product design cycle. An example from computer hardware
manufacturing, where Intel is the supplier and HP, Dell, Acer, Asus etc. are the customers using Intel’s microprocessors manufacturing laptops and desktops. Intel supplies early engineering samples to these OEMs. These early engineering samples are not running at the intended clock frequency, they have known “sightings” or bugs that are documented and have an overall reduced or subpar functionality. However, these samples are valuable for both the OEMs and Intel to iterate and improve their products. This B2B practice needs to be adopted in the B2C world as well wherein the customers help in the product development by getting involved early on in the design cycle, and in that process, help themselves by having a products just suited to their needs.

4.4.6 Detailed design
It is seen that crowdsourcing works best for high level abstractions of a product like a market need or product concept. For detail oriented view or the product, experts are required and the most companies like to keep it in-house. Moreover, it has been seen that the crowd participation decreases when the complexity of task is high. Tran et al. did an experiment to measure crowd participation in various phases or product design. They found that out of total 71 submissions over five product development phases (ideation, concept, detailed design, prototyping and testing), only 5.6% of the submissions were for the detailed design (Tran, Hasan, & Park, 2012). While Trans experiment suggest that crowdsourcing does not work for complex tasks, other forms of open innovation may be used during the detailed design phase. Suppliers and independent experts can be subcontracted for a specific subsystem design. Feedback may be collected from the current and perspective users for key user visible design features. For example, during the design of Fiat Mio, the fiat designers continuously sought feedback for design choices that concerned the end users (IdeaConnection, 2010). An example for a car would be the colors, interiors, and user interface design etc. Social media can be of great help in collecting real time feedback as the design evolves.

An exception where Crowdsourcing may be used even in detailed design phase is in the “Industrial Design”. Phone manufacturer Nokia uses IdeasProject for industrial design concepts. Figure 32 and Figure 33 show two designs submitted on Nokia’s Crowdsourcing website. It can be seen that the submitted designs are good quality and even if Nokia chose not to use the complete design, the internal industrial design team can always use some good design elements. Also, since these submissions get rated by the other users on the IdeaProject
website, Nokia Industrial designers can get valuable design cues about what look and feel would people like in a Nokia phone.

Figure 32: User Submitted Design for Nokia Windows8 Smartphone, Source Nokia IdeasProject Website
4.4.7 Opening up Supply Chain and Manufacturing

Manufacturing is a capital-intensive business. Many companies chose to outsource the manufacturing to China due to the capital constraints and specialized resources and manufacturing experience required to profitable manufacture the product (Learning curve effect). Even after the final production intent prototype is ready, ramp up on tooling and manufacturing takes time. Time to market (time taken to realize revenues out of an invention) is always a race between competitors. Every day slipped in the factory after product launch (announcing the product) costs a day worth of lost sales. Every day lost in manufacturing is a day lost from the product refresh cycle. Worse is when the competitor puts a competing product in the market and the market share is lost. Using multiple manufacturing houses is one strategy to reduce the risk of schedule slippage. This practice is more common in fabless semiconductor companies wherein more than one foundry is used to manufacture the silicon chips.

One problem associated with outsourced manufacturing is the disconnect between the product design processes, manufacturing and sales/marketing processes. This disconnect is mostly due to IP and sensitive sales data protection issues. Better integration with the manufacturing via Internet, social media can shorten the time lag between forecasts and manufacturing and reduce oscillations and inefficiency in the manufacturing processes (Sterman, 2000).

The extent of “opening up” of the supply chain and manufacturing has been so far limited to outsourcing and IT integration. Some companies use UPS and FEDEX as their logistics partners. While partnering is a form of open innovation, the digital disruption and social media has not yet benefitted manufacturing as much as it has benefitted other parts.

4.4.7.1 3D printers democratizing manufacturing

3D printing is an interesting technology which has the potential to bring the benefits of digital disruption to manufacturing. Personal 3D printers are available at a thousand dollars price point. Open source 3D printable designs templates are available on Internet. Under creative commons license these designs can be reused, enhanced and shared. With personal 3D printer’s technology getting mature every day, realizing a concept into a prototype has been easier and cheaper than before. In addition to personal printers, there are many online services where small inventors can upload their designs and get the manufactured prototypes by mail.
The concept of networking and social community can potentially network these printers and in principle, a distributed online factory can be created wherein any user can submit designs on multiple printers running in parallel and get deliveries by mail. While this may be a stretch of imagination, today’s technology is capable of doing this.

4.4.8 Social Product Marketing

Word of mouth and viral marketing is a well-accepted practice enabled by social media. Almost all companies today have their Facebook, twitter pages and YouTube channel. Companies showcase their innovations and demos on YouTube and Vimeo. They connect with customers and fans on the Facebook fan page. Blogs by marketing communication and external reviewers play an important role in communicating the product message to the customer even before the product is launch. Even rumor websites for highly sought after products generate a lot of marketing buzz. For example, there are hundreds of Apple rumor websites speculating about the next iPhone or other apple products. Even if these websites are based on fewer facts and more speculations, they help Apple in marketing their next product even before it’s launched. Cisco, one of the world’s largest technology companies, is using Jovoto for finding compelling and exciting ways to communicate the value proposition for one of its most versatile routers (“jovoto / Projects,” accessed 12th December 2012). They are using creative power of masses on Jovoto: a mass collaboration and co-creation startup. They are conducting a contest that will generate ideas illustrating the business value that the new router offers to its customers around the world.

PayPal used Jovoto to create a video to better communicate the benefits of PayPal to the users. Jovoto in turn used its community of users to create a message that can be understood by the masses.

Crowdsourcing can be used to create marketing collaterals. The crowdsourcing portals used by many companies for idea generation can also be used for creating marketing collaterals, slogans, ads and brand messages. Below is an example from P&G’s connect and develop website. It’s a contest for transforming the Olay brand.
Co-creation can also be seen as a paradigm shift in the traditional branding paradigm. The brand message and the process of brand value creation was conventionally based on marketing messages created by the company. In the new co-creation paradigm, the meaning of the brand, and the value offered by the product is automatically created by the personal interaction of the customer (participation) with the product and its development.

4.5 Social Project Management

A complex product has lots of subsystems and interdependencies amongst subsystems. The product development process needs to be managed in terms of structuring and streamlining the necessary tasks. A big challenge in managing a complex project is managing the communication between teams working on development of interacting subsystems. A delay in communication slips the overall product schedule. Conventional, single point contact mode of communication (between project managers) is slow and inefficient in the present context. An added complexity is offshore and distributed teams in different time zones. Social media tools can address this communication challenge where issues and information can be posted and people can add comments. Many software companies today are using wikis, mailing lists and internal social networking tools to promote interaction between their own employees. This becomes more important in a co-creation setting when most of the team members are outsiders and the team is very unstructured. Social media can help solve a problem faster, collaborate better and increase cohesiveness in the team.
Typically a project manager needs to collect project specs, plan of record changes, hot issues and status the progress of various tasks. Communication of milestones and accomplishments is also important to keep the team informed and motivated to deliver. Thus a big part of project manager’s role is being the hub of information. However, as mentioned above, the hub can sometimes be a bottleneck and a distributed model of information flow can be more effective. Social media can be extremely useful in facilitating the flow of information as well as interpretation of information (through integrated analytics). One of the most worthwhile aspects of social media is virtual community where team members can share ideas and build upon them. Hot issues and problems can be discussed, real-time responses can be obtained from experts siting in different corners of the company. The engagement aspect of social media ensures faster response times than emails. If a problem gets solved quicker due to collaboration, trust is built across team members and morale is lifted. This is especially important if the company has offshore teams. Hash tags can be used in conversations and the comments etc. can be tagged for analytics and filtering. For example, a comment related to a display subsystem of a laptop computer can be tagged as #display, and later all #display comments can be filtered to generate a report or even a troubleshooting documents for later reference. Other valuable analytics information like, number of comments per bug fix, bug peaks, or number of iterations for solving a problem etc. can be extracted from the data. The analytics data is a valuable for making forecasts and planning for next projects.

The following are different forms of social media tools used today.

- “Social news media” e.g. twitter
- Virtual Communities e.g. Yammer, Google+, Facebook
- Freeform webpages e.g. Wiki
- Video and Podcasts e.g. YouTube, Vimeo

The above-mentioned tools can be directly used to manage external relationships, e.g. in a Crowdsourced project or they can be adapted/mimicked for managing internal development. Rather than sending emails waiting to be opened, Twitter or a twitter like tool can be used to float relevant information. Specific teams can subscribe to the feeds of their interests. Social networking websites like Facebook or Google+ can be used to share announcements, milestones and documents. Appreciations, team photos etc. can also be shared to lift employee morale. Important project moments can be captured in the “timeline” and real transparency
to all project stakeholders can be provided. The timeline can also reveal signature patterns of events, communication etc. useful for looking back in retrospect and applying the learning in future projects. **Yammer** is a social networking platform for business. It is used by **Xerox** to better connect employees and simplify business processes for clients around the world. **Cisco** uses an internal social platform to generate ideas and create a community of people signed up for a particular idea. Different teams working on an idea integrate their work processes on the social platform and do rapid prototype iterations accelerating time to marker.

Wikis are shared notebooks for teams. A user can add, delete or modify pages using a simple markup language. Wikis can be a document repository tool as well as a status-tracking tool. Team members can routinely update the wiki’s, which becomes instantly visible to other team members including the project managers. The system is independent of time zones since everything is real-time. Wikis can be access controlled and are available cross platform. Suppliers, factory, and even customers can access them. Wikis are extensively used in open source community. In fact, the entire Wikipedia is built on wiki pages.

A successful example using social media in managing offshore employees is CDC software, **CDC Software** uses social network at each phase of the development process to deliver software from teams around the world. The cloud-based social networking tools have helped CDC to promote collaboration and streamline knowledge transfer among their 14 R&D offices in different countries. With the use of social media, CDC cut the development cycle from 24 months to 12-16 weeks thereby cutting huge costs.
5 Discussion

A decade after Henry Chesbrough proposed the concept of open innovation in 2003, many companies have employed the concept in their innovation strategy and business model. Open Innovation is not just limited to joint ventures, technology licensing and open source projects. In this new age of digital disruption open innovation has expanded into tight customer integration, innovation communities, crowdsourcing and co-creation. Finding and acquiring patents is easier than ever before. Supplier and customer integration cost has gone down due to digital technologies; data and decisions are real time. The success of open innovation business models by P&G, Quirky, and Nokia has inspired many companies to jump on the open innovation bandwagon. The plenty of different forms of open innovation, the tools and agents can be handpicked and customized to suit any company’s innovation management practice. At the same time, these myriad options for external engagement can cause confusion and companies may end up making wrong choices. Before making any choices on the available open innovation tools and processes, a company should start with reviewing its own product innovation process and its outputs at each stage to find out which open innovation processes would serve the company’s business objectives. Section 5.1 describes a framework to assess a company’s innovation process The framework is derived from the work of (Muller et al., 2012) and (Terwiesch & Ulrich, 2009). Section 5.2 will summarize the efficacy of open innovation process and tools and it will serve as a guide to select open innovation tools and processes to complement or replace a company’s existing product design process.

5.1 Assessing the Product Innovation Process

A product innovation process typically comprises of three phases: Idea Generation, Idea development, and Commercialization. While Idea generation deals with generating new ideas of potential products and services, idea development process transform the most promising ideas into sellable products. Commercialization market tests the generated opportunity, adjust the business model and scales the opportunity for a market launch.

Managers should qualitatively evaluate the outputs at each of the above development stages. On a high level, they should know which of the above mentioned stages are deficient and where the new ventures typically stall and for what reasons do they stall.
Terwiesch and Ulrich further expand the idea generation into Opportunity Generation and Opportunity Selection (Terwiesch & Ulrich, 2009). They propose a tournament structure that focuses on sensing and screening opportunities even before the development begins. Idea Development and Commercialization can be tied into a formal phase gate process with clearly defined phases with gates, wherein go/no-go decisions are taken. Ulrich and Eppinger consider opportunity generation as a key task in the product planning process (Ulrich & Eppinger, 2008). While structure and managerial rigor can be applied to the idea development and launch, the idea generation is a “fuzzy front end” which historically has been managed loosely and has been an area of deficiency for most of the companies. Most companies generate their ideas internally despite of the fact that many blockbuster products ideas came from outside. Red bull, Nintendo Wii and the billion dollar iPod were all acquired products or prototypes from startups operating in small independent niches. Terwiesch and Ulrich emphasize on the importance of generating a stellar opportunity to feed into the stage gate development and commercialization process. Since, getting a billion dollar opportunity is a chance event, the only way to maximize the odds is to generate as many diverse opportunities as possible (Girotra et al., 2010). Resource constraints and conventional thinking are enemies of ideation process. Open Innovation methods can come to a company’s rescue, however first they need to correctly assess if the existing innovation process is deficient.
5.1.1 Assessment of Opportunity Generation Process

Terwiesch et al. propose the frameworks to assess the deficiencies in the Idea Generation frontend (Terwiesch & Ulrich, 2009). The frameworks are summarized in form of questions that can be used to assess the suitability of Open innovation methods in the respective areas of deficiency.

1. Assess the In-House Opportunity Generation
   a. Are there sufficient individuals identified to generate or lead opportunity generation?
   b. Is the business condition or company culture allowing the employees to regularly devote time outside their projects for idea generation / prototyping?
   c. What administrative techniques, templates and processes are used for opportunity generation?
   d. What is the quality variance of the ideas generated internally?

2. Where are the best innovators related to your product or industry? Allocate 100 points in the chart below. Use the distribution on the chart below to assess the innovation capability and leverage the right external source in your own product design process.

![Diagram of where are the top innovators in your industry](image)

Figure 36. Where are the top innovators in your industry? Source: (Terwiesch & Ulrich, 2009.)

3. Assess the outside sources of idea generation
a. What percentage of opportunities come from outside sources? What is the mix from customers, suppliers, distribution partners, universities etc.? Is there enough diversity? Does the sources of ideas correlate with the Chart above?
b. What specialized expertise and scale is required for innovating in your industry?
c. What are the channels of sensing information? Is there a person or team assigned to scan information from outside?
d. Do you have a process and resources in place (NDAs, External access to company’s intranet and internal shared spaces, Wikis etc.) for collaborating with external innovators?

4. Assess the Selection Process: The goal of idea generation is to collect a pool of high quality and diverse ideas, both incremental and radical. Considering the low probability of an idea making it big in the market, the strategy should be to generate as many ideas from as many diverse sources as possible. While crowdsourcing and innovation tournaments can help generate hundreds of ideas quickly and cheaply, the problem of selecting the good ideas economically and accurately is always a difficult one. The following questions assess the weaknesses in the existing opportunity selection process.

a. Is there an opportunity screening process? How efficient or time consuming is it? What is the role of external agents in the selection process?
b. Is there a web based idea management system in place?
c. Is there a set of criterion to guide the selection process? What is the portfolio strategy in choosing ideas for development? Are the criterions known by everyone?
d. Is there a voting mechanism in place? What kind of dynamics exist in a voting process (Group behaviors)? Is there a mechanism to vote anonymously?

The above mentioned set of questions give a status of current state of affairs as far as the idea generation process is concerned. If it’s found that, there are insufficient external ideas, or internally generated ideas do not have sufficient quality variance, or the selection process is
too bureaucratic and time consuming, may be its time to use some of the open innovation methods described in Chapter 3.

5.1.2 Assessment of the Profitability and the Business Model

A product opportunity is accompanied with a business model. As the product is developed, the business model is defined around the product. A business model helps to identify the key value creation areas and strategizes value extraction. A company would like to keep core innovations or the most strategic value creation part internal and offload the non-strategic parts to external partners. On the other hand, the company may want to be the integrator and control different external innovators under one umbrella ad extract the value from integration. In order to do that, it’s important to understand the business model associated with the product.

In their paper, Muller et al. list a set of five questions that define the business model around a new innovation.

1. Who is the target customer and what are the unarticulated needs they possess?
2. What is the product or service and what is the value proposition?
3. How will it create competitive advantage that is sustainable?
4. What is the value chain and where does the company play?
5. How will the venture create value for the company and the key stakeholders?

The competing priorities time and resources and the conflict between short term profitability and long term growth forces companies to abandon new ideas prematurely. Some ideas may progress further and develop into a promising product. However, at that stage it is important to assess if the product will be able to distinguish itself and achieve a sustainable competitive advantage in the market. Open innovation can help here in two ways. It can enable the product design team periodically get real-time feedback during development thereby increasing the chance of market acceptance. Secondly, it can also help to totally spin off the development of non-core products to outside companies (inside-out process). The business model assessment can also help a company to leverage external partners (even competitors) to fill in missing links in the value chain.
5.2 Applying Open Innovation Methods

Adopting open innovation does not necessarily mean replacing the existing product innovation process as a whole. Rather, open innovation tools and methods should be used as a complement to the existing product innovation process. The idea is to leverage external partners and create more value for the company by more innovations to market: Both by acquiring and releasing innovations. Critically reviewing the challenges and limitations of open innovation tools and methods is equally important as reviewing the company’s existing innovation process. The next section describes limitation of crowdsourcing, a popular open innovation tool. While the below mentioned limitations apply specifically to crowdsourcing, some of them also apply to open innovation in a general sense.

5.2.1 Limitations of Crowdsourcing

When a company thinks about open innovation, crowdsourcing is the easiest to consider due to the low transaction costs and apparent resource requirements. Crowdsourcing can deliver the goods if applied in the right problem solving environment. However, it's not a solution for each and every type of innovation problem. Also, the overhead cost of managing the large amount of generated ideas can sometimes outweigh the benefits. Therefore, the limitations and challenges should of using crowdsourcing as an idea generation tool needs to be understood before allocating the company’s resources in this direction.

Crowdsourcing often is implemented as a one way interaction between the individuals submitting solutions and the company posting problems. This may work for a well-defined isolated problem, but not necessarily for problems in product design which are inherently iterative. Collaboration is the key when the problem and solution are tightly intertwined and a slight change in problem statement may completely change the solution. For problems in product design, co-creation may be better suited as it facilitates a two way collaboration between the company and customers rather than just idea harvesting.

Crowdsourcing works effectively when a problem is clearly defined such as a science problem or software development. Codification is important and in sectors where this clear problem definition is difficult, crowdsourcing will be ineffective (Burger-Helmchen & J. Penin, 2010). The challenge of ideation is shifted to problem definition and this may outweigh the benefits of crowdsourcing especially when the problem definition changes.
Another issue with ideas generated via crowdsourcing is feasibility of the ideas. Although the ideas generated via crowdsourcing are higher in quality as compared to the ideas generated by an in-house product team. However, they are low on feasibility score. Poetz and Schreier measured quality of ideas in a company using crowdsourcing for idea generation in making baby products. They measured the idea quality on the parameters of novelty, customer benefit and feasibility and found that the ideas scored better on novelty and customer benefit and lower on feasibility (Poetz & Schreier, 2011). Thus, product teams need to be constantly scrutinizing the feasibility of generated ideas. The large number of ideas is a challenge but selection methods described in chapter 3 can be used to narrow down to a manageable list.

Finally, there could be legal issues related to the ideas submitted or developed via crowdsourcing. The ideas themselves can be derived or directly copied from a published or unpublished source. Even if the ideas are original, the ownership and acquisition of these ideas is a legal challenge which could be costly as well. Since these ideas are publically revealed, they cannot be patented.

Although the above mentioned limitations and challenges are described in context of crowdsourcing, some or all of them apply to a certain extent to other forms of open innovation such as customer integration, Community based co-creation, Venture investing etc.

5.2.2 Dominant Modes of Participation

From the study of more than 50 startups and established companies utilizing open innovation, a dominant mode is observed. From Figure 38, it can be observed that majority of companies utilize open innovation methods in Planning (Ideation, See section 4.4.1), concept development, Distribution, Sales and Marketing. Almost all of the companies (except for software) like to keep the detailed design and production in-house, or closed. Kim et al. design and studied and classified 33 cases of companies applying crowdsourcing to new product design (Kim, Ahn, Tran, Nguyen, & Park, 2010). They found that, in 60% of cases, crowdsourcing was employed in customer needs and concept development. This was followed by testing (20%) and detailed design and commercialization (20%). Similar results were obtained by an experiment done by Tran et al. (Tran et al., 2012). The experiment was set up as a Crowdsourced product design challenge. The experiment ran for 75 days with an aim to completely develop a product from idea to final prototype. There were five generic phases namely
1. Idea Generation
2. Concept Design
3. Detailed Design
4. Physical prototyping
5. Design Evaluation or Testing

The contest website had over 3000 visits during each of the above mentioned phases of the contest. However, the number of solutions submitted during each phase show a trend similar to Kim et al. and the one shown in Figure 38.

The data by Kim et al, Tran et al., and Figure 38 show that tasks which require more skill and detail, is less attractive for the crowdsourcing participants. One reason for that could be lack of specialized skills and another one could be the transaction costs. Detailed design prototyping are complex tasks and as suggested by the data above, participation of a community decreases with the complexity of the task. The phases which require less skills and efforts like idea generation and concept design are attracting more participants. If we look at the types of problems posted on most crowdsourcing websites or community based product development, the depth of expertise required is relatively low. Additionally scale of investment is also low. Terwiesch and Ulrich also present a framework to map the idea on the axis of complexity and scale of investment. The position of the product on the expertise vs. investment map helps decide which route to follow: open or closed?
<table>
<thead>
<tr>
<th>R&amp;D</th>
<th>Planning</th>
<th>Concept Development</th>
<th>System Level Design</th>
<th>Detailed Design</th>
<th>Testing and iterations</th>
<th>Production</th>
<th>Distribution Sales &amp; Marketing</th>
<th>Service and Support</th>
</tr>
</thead>
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<tr>
<td>Innocentive</td>
<td>Quirky</td>
<td>Quirky</td>
<td>topcoder.com</td>
<td>topcoder.com</td>
<td></td>
<td></td>
<td>Quirky</td>
<td>Quirky</td>
</tr>
<tr>
<td>TekScout</td>
<td>Kickstarter</td>
<td>Innocentive</td>
<td>Yeti2.com</td>
<td>mobforhire.com</td>
<td></td>
<td></td>
<td>Guerra Creative</td>
<td>Microsoft</td>
</tr>
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<td>IdeaConnection</td>
<td>Innovation Exchange</td>
<td>TekScout</td>
<td>topcoder.com</td>
<td>uTest.com</td>
<td></td>
<td></td>
<td>Brand Tags</td>
<td>Apple</td>
</tr>
<tr>
<td>One Billion Minds</td>
<td>ideakon</td>
<td>IdeaConnection</td>
<td>Challenge.gov</td>
<td>threadless</td>
<td></td>
<td></td>
<td>LeadVine</td>
<td>Google</td>
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<tr>
<td>Hyplos</td>
<td>Idea Bounty</td>
<td>Battle of concepts</td>
<td>spreadshirt</td>
<td>IBM</td>
<td></td>
<td></td>
<td>99designs</td>
<td>Freescale</td>
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<td>Innegot</td>
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<td>Brackrack</td>
<td>threadless</td>
<td>Microsoft</td>
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<td>Sourcing.com</td>
<td>Analog Devices</td>
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<td>NineSigma</td>
<td>NineSigma</td>
<td>crowdSPRING</td>
<td>Naked &amp; Angry</td>
<td>Apple</td>
<td></td>
<td></td>
<td>Intra Trade</td>
<td>Intel</td>
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<tr>
<td>NewsFutures</td>
<td>booth.com</td>
<td>dreamheels</td>
<td>Google</td>
<td>NewsFutures</td>
<td></td>
<td></td>
<td>Ushahidi</td>
<td>Linux</td>
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<td>Kaggle</td>
<td>RedesignMe</td>
<td>Jovoto</td>
<td>arrange</td>
<td>sparc</td>
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<td>Kaggle</td>
<td>Whirlpool</td>
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<td>sparc</td>
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</table>

Figure 38. Dominant Mode of use of Open Innovation Methods
5.2.3 Other Open Innovation Challenges

Other than the limitations mentioned in the previous section, West and Gallagher describe the three challenges in integrating external and internal innovation (West & Gallagher, 2006a).

- **Maximization.** To maximize the return on investment, a wide range of diverse approaches are required. Just limiting to crowdsourcing or other inbound open innovation processes may not be sufficient. Not only the companies should use inbound processes to fill in the product pipeline with ideas, but also they should use outbound innovation processes like licensing, toolkits, patent pools and giving away technology for free. Many companies fall short in their own strategy of open innovation by just employing the easiest of the methods: crowdsourcing and generating ideas for free. However, that may not always work out in the favor of the company since there would be always risk of feasibility and scalability of the ideas.

- **Incorporation.** Firms may not benefit from the sea of external knowledge available unless there are right processes set up to filter the relevant knowledge and absorb it into the internal innovation processes. Scanning the right sources of innovation, absorptive capacity and the culture to embrace external innovations are the key to gainfully incorporate open innovation. A company, that is highly successful in the closed innovation paradigm, will not have the trust and confidence on eternal innovations. Also, the absorptive capacity to incorporate external innovations is low in such companies.

- **Motivation.** The motivation challenge is two pronged. On one hand, it’s a challenge to motivate the employees of a company to give high visibility innovation opportunities to outsiders. On the other hand, it’s difficult for a company to release its IP to outsiders and sometimes competitors. It’s much easier to adopt inbound open innovation processes since there is at least no loss in getting ideas and technology from outside. However, the motivation for releasing innovations outside is difficult decision for the companies due to lack of short term and direct benefit. If a company decides to release its innovation for free or no short term financial incentives, short term profitability will suffer and consequently, the firm may tend to reduce the annual R&D budget. As a result, the company in question will not have anything to share with the
outside world for the next year. This negative feedback creates a balancing effect which is not sustaining the free outflow of innovations. Apart from organizational motivation, there are individual motivation challenges as well. Motivating individual external innovators to generate and contribute their innovations with little or no financial incentives is difficult and alternative motivation methods need to be carefully planned to motivate individuals to contribute their innovations for free (Lakhani & Wolf, 2005).

5.2.4 Guide for applying open innovation

Muller et al. summarize the phases in product development where open innovation can help. Figure 39 presents the summary of diagnostics and sources of open innovation (Muller et al., 2012). The assessment done in section 5.1 will help answer the questions for each of the three product development stages.

<table>
<thead>
<tr>
<th>You need to consider open innovation if . . .</th>
<th>Idea-generation</th>
<th>Idea-development</th>
<th>Commercialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas arise from a very limited number of novel insights</td>
<td>A large proportion of innovations are abandoned</td>
<td>Commercialization costs often exceed forecasts</td>
<td></td>
</tr>
<tr>
<td>Ideas come only from a small number of employees</td>
<td>New innovations fail to attain sustainable competitive advantage</td>
<td>Commercialization takes too long and often misses the market window</td>
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<tr>
<td>The same ideas continue to arise</td>
<td>Day-to-day business crowds out time &amp; resources for idea-development</td>
<td>Missing links in the value chain inhibit value capture</td>
<td></td>
</tr>
<tr>
<td>Ideas are mostly incremental</td>
<td>Idea-development is a &quot;part-time&quot; effort and accountability is unclear</td>
<td>Commercialization relies on owned technologies and processes and existing distribution channels</td>
<td></td>
</tr>
<tr>
<td>Ideas fail to connect with consumers or excite employees</td>
<td></td>
<td>Integrating suppliers</td>
<td></td>
</tr>
<tr>
<td>Ideas are all focused on products and not on other aspects of the business model</td>
<td></td>
<td>Licensing</td>
<td></td>
</tr>
<tr>
<td>Sources of open innovation</td>
<td>Experts for insight sessions</td>
<td>In-house venture-capital funds and in-house incubators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insight scouting</td>
<td>External venture capitalists</td>
<td></td>
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<tr>
<td></td>
<td>Customers</td>
<td>Innovation capitalists</td>
<td></td>
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<tr>
<td></td>
<td>Inventor communities</td>
<td>Small companies with innovative products (acquisition)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crowd-sourcing</td>
<td></td>
<td>Distribution partners</td>
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<tr>
<td></td>
<td>Idea brokers</td>
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</tbody>
</table>

Figure 39. Where to apply Open Innovation (Source (Muller et al., 2012))

West and Gallagher discuss some management techniques to counter the open innovation challenges described in section 5.2.3. The challenges and resulting management techniques are summarized in Figure 40.
Figure 40. Open Innovation Challenges and Management Techniques to counter them (Source: (West & Gallagher, 2006b))

P&G’s connect and develop model has been a very successful for them but it also has gone through iterations of methodical processes of learning by doing over the last decade. Huston and Sakkab identify three key requirements for successfully implementing a “connect and develop” style open innovation strategy (Huston & Sakkab, 2006b).

- The ideas obtained from outside never directly realizable. There is always a risk of feasibility and scale-up. Absorptive capability and a great internal design team is a must to incorporate the external innovations into blockbuster products.

- Even though the ideas and innovations may be obtained for “free”, there is still a need for full time senior management (other than a product design team) to run the open innovation initiative, decide and execute strategies to maximize ROI, to motivate the individual contributors and build an innovator community.

- Mandate from the CEO is a must. A connect and develop style open innovation initiative cannot succeed if it’s isolated within R&D and not top down across the organization.
6 Conclusion

Open innovation concepts are finding applications not only in software but across different industries as evident in the different cases discussed in this thesis. I started with the importance of innovation for product companies and the challenge of sheer pace of innovations necessitating external help to fill up the innovation pipeline. Frost and Sullivan survey rightly pointed out the lack of processes and sufficient resources to manage the sources of innovation. Open innovation is the possible answer to many of the R&D challenges and many large companies and startups are using open innovation to jumpstart into new product development or a non-core far-horizon business.

A taxonomy of open innovation is developed to help managers understand the different modes and methods of open innovation. The taxonomy also has a toolbox which has tools applicable to various innovation challenges in modern product design. A study of the conventional and modern product design processes (aided by digital disruption and social innovation) is done and with an attempt to draw parallels between the two processes. A new mode of open innovation in modern product design, termed as digital disruption is enabled by internet and mobile communication technologies. Various examples from different industries suggest that digital disruption is helping companies to adopt open innovation in idea generation, concept validation, prototype testing, marketing and branding. Co-creation processes are now a standard innovation process in many large and small product firms. Some startups have lead the way in opening up the complete product design process including the financials, right from the idea to the launch. The digital disruption has democratized even the funding by bringing hundreds of venture investors investing large sums and the masses pledging for small amounts crowd (Crowdfunding), thus enabling startups raise the seed capital necessary for prototype development. The social sales model enabled by the internet based communities has lowered the barrier of building relationships with suppliers and distributors. The cycle time from idea to sales has shortened considerably over the last ten years.

Open innovation is also a strategy, which like other strategies, it only effective in specific situations and its execution should be sensitive to the context. Open innovation is not a silver bullet for resurrecting an ailing product portfolio or replenishing a dwindling innovation pipeline. A number of aspects of new product development like IP rights, process management, communication, project management, information systems etc. has to be
understood before considering an open innovation strategy. The goals of implementing this strategy should be understood and design of the custom strategy should be driven by the goals. After the goals are set, the current innovation processes and the business context should be understood to determine which open innovation tools and processes should be used.

Major challenges in using crowdsourcing should be considered before investing a company’s resource in managing a crowdsourcing process. The trade-off between creativity and feasibility should be made by the managers when considering crowdsourcing as a tool.

To conclude, academic literature on open innovation has already generated a lot of useful concepts which can be applied in product design. A few companies are already leveraging these tools effectively and there are many others which have started jumping in the open innovation bandwagon. A taxonomy of open innovation and compilation of case studies related to open product design aided by digital disruption have been discussed to help understand this concept better from the lens of product design. Going forward, there are many opportunities for further extending this work. A few on my top list would be

- Empirical evidence to understand the effectiveness of open innovation tools across different industries.
- Levers to improve the effectiveness of open innovation in product design.
- Evaluating the risks of integrating open innovation processes in the organization.

While future research on above mentioned ideas is necessary to further develop the understanding and applicability of “Digital Disruption” and “Social Innovation” paradigm, I feel that a good starting point to adopt open innovation in product design is established in this thesis. This thesis should encourage companies to consider open innovation while tackling relevant product design and innovation challenges.
7 References


ENDNOTES

i William Addis is credited with the invention of world’s first modern toothbrush. The first patent was filed in 1857. Mass production started in America around 1885 and electric toothbrushes by squibb and company in 1960. http://www.towerhamlets.gov.uk/news_events/east_end_life/8_august/william_addis_cl
eaned_up_with.aspx
http://www.loc.gov/rr/scitech/mysteries/tooth.html

ii www.quirky.com. Quirky is a social product development platform with majority of the product development process executed by community of users and inventers.

iii The New Product Pacesetters list is published by the independent analytics firm Symphony IRI Group, Inc. Acknowledged as the industry benchmark for new product launches, the list recognizes consumer packaged goods that achieve at least $7.5 million dollars of sales in their first year of distribution.

iv Harvard Business School interview with A.G. Lafley, CEO of P&G, as posted on YouTube http://www.youtube.com/watch?v=xBsXrffc

v Higher transaction costs deter community participation. Information management overhead discourages the practice of open innovation.

vi https://ideasproject.com/idea/-/ideas/1331790. The smell sensor is a sticker applied to smartphone or incorporate to phone case. The sensor enables interesting applications for a smartphone. These sensors also can be a product for different social applications.


ix Source of data: http://www.quirky.com/about accessed 11th April 2013

x https://www.bmwgroup-cocreationlab.com/cocreation/project/customer-innovation-lab

xi https://www.bmwgroup-cocreationlab.com/cocreation
Bush Boake Allen, a flavor and fragrance firm is considering strategic options that would integrate customers into its innovation process via a potentially disruptive Internet-based technology.

Mobile Operating system by Google

Inc.com estimated a sales of $30Million in 2008.

The source of this data is an opportunity generation project done over the summer of 2012 at Analog Devices. I was the project lead and the project goal was to generate new product ideas for a new technology startup acquired by Analog devices. In a span of 3 months, 180 ideas were created from 4 teams of 7 participants each. 45 of these ideas were filtered and presented to the senior management by doing 2 minute pitches. Finally top 10 ideas were put into the innovation pipeline and top three ideas were actively pursued as viable products.

See note # xv

PepsiCo’s 2008 R&D Budget was $388 Million. Source: Bloomberg BusinessWeek

See note # xv

www.intuit.com

Harvard Business School interview with A.G. Lafley, CEO of P&G, as posted on YouTube http://www.youtube.com/watch?v=xvIUSxXrffe

https://ideasproject.com/idea/-/ideas/1307369

Jovoto is a mass collaboration startup for community based social product design. http://www.jovoto.com