How to Inject Innovation into DfSS Projects

An Overview of the Systematic Innovation Process

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Abstract

Systematic innovation. To many people this may sound like an oxymoron however skilled facilitators are working with product development teams to induce innovation on demand with increasing frequency. Many organization's extensive experience and engineering expertise within their focused product line is both a blessing and potentially a curse when developing new products required to maintain any strategic advantage that they may have. The depth of their knowledge can inhibit more lateral thinking that may lead to break through technologies, products and systems. That is the body of knowledge where systematic innovation comes in. It starts with first a solid understanding of the voice of the customer (VOC). The VOC is then translated to solution neutral functional requirements, setting the stage for innovation. Systematic innovation then allows engineers to apply tools to achieve a lateral thinking approach to think divergently first around a design problem to develop a set of solutions that include 'outside the box' concepts. These concepts, based on the VOC are then hybridized (leading to more ideas), detailed and evaluated before converging on the best solution to take forward in the product development process to embodiment of design.

Being able capture the voice of the customer, translate the requirements and then apply systematic innovation is key to any organization developing world class products and to developing a sustainable competitive advantage over their competition.

Introduction

Systematic innovation. To many people this may sound like an oxymoron however skilled facilitators are working with Design for Six Sigma (DfSS) teams to induce innovation on demand with increasing frequency. Most organization's extensive experience and engineering expertise within their focused product line serves as both a blessing and potentially a curse when developing new products required to maintain any strategic advantage that they may have over their competition. The depth of their knowledge can inhibit more lateral thinking that may lead to breakthrough technologies, products and systems. This is the body of knowledge where systematic innovation comes in. It allows DfSS teams to apply tools to achieve a lateral thinking approach to think divergently first around a design problem. The teams then use the divergent thinking to develop a set of solutions that include 'outside the box' concepts and then to converge on a potential innovative concept.

Systematic innovation also enhances the effectiveness of the DfSS methodology. It is well documented that there are four key phases to a DfSS project:

1. voice of the customer,
2. innovation and creativity,
3. statistical design and robustness, and
4. verification and validation.

This may be the case, however many DfSS projects focus primarily on the statistical design and robustness, leaving the impression that DfSS is only a process that enhances the embodiment of design of a given product development effort. With this view of DfSS, projects are relegated to delivering increment improvements through highly quantified design. This may be a drastic improvement for many organizations but what if innovation could be induced on demand, offering breakthrough solutions? This is also the body of knowledge where systematic innovation is useful.

The dilemma facing many DfSS project teams is they lack a repeatable, standardized but flexible process for operationalizing systematic innovation. Many groups, if they even attempt to tackle innovation in their projects, will rely on product development activities as a course of normal activities to deliver breakthrough concepts. A few more advanced groups may even try brainstorming. What these groups fail to realize is that the very skills that have made them effective product development engineers and technical personnel, may hinder their ability to be creative.

Definition and History of Systematic Innovation

To understand systematic innovation, we must first understand its definition. In order to have innovation one needs to know the customer wants and needs and then develop an invention to fulfill them. According to Huthwaite (2007), creativity is the practice of developing new, outside the box ideas. An invention is then the 'thing' that comes from the link of creative ideas. Not all inventions fulfill a need and thus are not a benefit to society. Innovation is when an invention is used to fulfill a consumer want. Systematic innovation is then the process of identifying the customer want, developing creative ideas, inventing something that meets that want, on demand. This is made easier by following a facilitated, structured process.

The notion that innovation can be facilitated to produce on-demand ideas with breadth and depth is a relatively new phenomenon. Per George Land (1997, 1998, 2006), who is a pioneer in the field of innovation, the prevailing thought through the 1950's – 1970's was that people were inherently either innovative or not and that creativity was a character trait. The efforts at this point were more centered on identifying individuals with this character trait and researchers like Land developed profiling mechanisms to label individuals based on the innovative potential. These profiles were used to identify key people who think outside the box, and to deploy them whenever new ideas were sought or difficult problems came about. Since these people's thought patterns were more divergent, they often had a difficult time leveraging more convergent thinking skills. Convergent thinking is necessary in every day business situations to drive results and without these skills the more creative thinkers usually had a difficult time fitting in and were isolated except in those cases where their skills were required. These profiling mechanisms including a creativity test created by Land were used by many large organizations including NASA. This "character" approach to innovation was the prevailing way many organizations sought to inject innovation into their organizations until George Land published his breakthrough through study that changed the paradigm with respect to how people thought about innovation.

In 1968, George Land embarked on a multi year study where he took his creativity test used by NASA to select innovative engineers and scientists and administered it to a 1,600 5-year old children. He re-tested the same children at the age of 8 and then again at the age of 15. He also tested a number of adults of various ages. The results were that the 5 year olds scored as well as some of the highest ranked engineers and scientists at NASA with respect to their innovation aptitude. However, the same children's score dropped by over 50% when they were re-tested at age 8 (after they started school). Land reported that the innovation aptitude continued to decline as each individual aged, bottoming out by the age of 44. Another interesting trend that Land uncovered was that the innovation aptitude took a sharp rise at retirement age. The conclusion was that innovation is more of an unlearned behavior rather than a character trait. The majority of people are innately creative as a child but as soon as they begin schooling and are subjected to structure, rules and peer pressure, they begin to develop psychological inhibitors that hinder the creative nature but help them conform to society. What is extremely interesting is that typically the more education and experience a person has, the stronger the psychological inertia becomes to conform, rely on previous experiences and stick to prevailing notions. Land concluded that innovation is not learned by adults, but that it is more of an un-learned behavior. Uncreativity is behavior that is learned.

This epiphany changed the body of knowledge surrounding systematic innovation in the 1980s and beyond. Tools, methods and processes began to be developed to deploy systematic innovation to remove barriers, restore the inner child thinking, bolster innovation, overcome the psychological inertia and to ensure that innovation is repeatable and reproducible on demand. The thought that facilitators could deploy a process to induce innovation at critical junctures in the DfSS process became an inviting idea to development managers around the globe. The basic premise is that if the product and application engineering knowledge is present and if the customer requirements, (wants and needs), are understood, then facilitators could apply a process leveraging creativity techniques to develop innovative concepts. This process could be implemented on demand when required within the DfSS roadmap.

The Systematic Innovation Process

While there are many ways to implement the process of Systematic Innovation, an effective alternative is to run a sort of innovation kaizen event. A kaizen event is a well known technique used in the Lean Thinking continuous improvement body of knowledge where cross functional teams take time out from their normal activities to focus on improving the processes they work on. The same notion is applied to systematic innovation where cross functional teams gather, usually for a couple days, to focus on the specific task of generating breakthrough ideas to feed their particular project. The notion of congregating in a different place, in a relaxed atmosphere, with a highly cross functional team, in a facilitated environment, with a specific focus on thinking outside the box, puts the teams in a position to generate ideas that they would typically have a difficult time coming up with in their normal work flow.

The systematic innovation process outlined in this paper was partially adopted from Bart Huthwaite's Rules of Innovation (Huthwaite, 2007). Huthwaite's Innovation Cube process was taken as a baseline then adapted to meet the needs of product development teams working within a DfSS project. The process was adapted to incorporate tools and techniques within the DfSS body of knowledge as well as to leverage some already existing creative thinking techniques (Samuel, 2008). In summary the process has borrowed previously published techniques and packaged them in a fashion that brings results for teams that use them. The result is a repeatable but flexible blueprint for carrying out systematic innovation that is able to be leveraged within the context of the DfSS roadmap. An attempt will be made to site all relevant references however many of the techniques outlined in this paper have been utilized openly by product development teams around the globe for many years.

The key to successful DfSS systematic innovation is to first develop the voice of the customer (VOC). If the needs of the customer are not first understood, the result is often developing products and solutions that do not hit the target market. Every year, many product development resources are committed to developing products that deliver what engineers think the customer wants rather than what they actually need. Developing the VOC is taken in 2 phases. First, the voice of the customer must be captured from the actual customers. Then, the VOC must be translated into a form which can be used by the DfSS team. This form will outline the measurable key characteristics used in the systematic innovation process. These key characteristics (some times called functional requirements) must be solution neutral in order to properly position the innovation event to deliver breakthrough and not more incremental ideas. Capturing and translating these measurable, non-solution specific, key characteristics is a prerequisite to the systematic innovation process.

After the VOC is understood the systematic innovation process can be deployed. The major steps in the systematic innovation process are;

1. preparation phase - kaizen inputs,
2. setting the stage for innovation,
3. divergent innovation,
4. convergent innovation,
5. concept hybridization and ranking, and
6. concept detailing.

The first two steps, preparation phase and setting the stage for innovation, set up the project and get the team prepared to think in a different manner. The divergent innovation step opens up the challenge, leveraging tools to identify a number of innovation bits. The convergent innovation step takes the innovation bits and converges on breakthrough concepts. During the concept hybridization and ranking step the team will rank the different concepts and apply synergy to develop some new concepts. Finally, in the concept detailing step, the concept that is selected to continue in the DfSS project is documented to ensure information from the innovation event is carried on to the embodiment of design.

1. Preparation Phase

The first step of the systematic innovation process is the preparation phase. The preparation phase contains the things that must be done to prepare for the kaizen event and are thus done before pulling the entire team together for the event. These activities are typically completed within a smaller core team led by the project leader and assisted by a facilitator. The facilitators are qualified individuals who are the experts in the systematic innovation process and use of creativity tools. The preparation phase opens up the problems and prepares the team for innovation. The first part of the preparation phase involves developing the goals and objectives of the project. This is typically captured in the DfSS project charter or statement of work and should outline specifics including: the goal of the effort, the scope, timing, budget considerations, the business case, market considerations, etc.

Another important input to the systematic innovation process preparation phase is to establish a well defined project and product scope. Defining the scope involves understanding the DfSS project boundaries and hurdles. The boundaries reflect the scope limits that the project must be contained within. The hurdles represent the challenges the project must over come. In addition to understanding the boundaries of the project, it is important to understand the boundaries of the product. This involves understanding the product inputs and outputs as well as any system / subsystem interdependencies. Defining the product boundaries will remove any ambiguity between the customer and supplier with respect to the interactions and deliverables the product may be required to provide. A facilitator will leverage specific tools that enable the capturing of relevant deliverables of the preparation phase.

2. Setting the Stage for Innovation

Setting the stage for innovation is the first phase in running the actual systematic innovation kaizen event. The purpose of setting the stage for innovation is to begin to remove the mental blinders of the participants and to put them in a good frame of mind for creative thinking. Setting the stage for innovation starts with an opening message by the DfSS project sponsor or another senior leader from the organization. The goal of the opening message is to demonstrate the leadership support for the effort, to reinforce the importance of the effort and to thank the participants in advance. A well delivered opening message from leadership will help to ensure the kaizen event gets off on the right track and will leave the team inspired and ready to tackle the challenge at hand. The opening message should outline the business case for the DfSS project and link the strategic objectives of the organization.

The next phase in setting the stage for innovation is to bring the entire team up to speed on all of the parameters of the project developed in the preparation phase including the scope, boundary and hurdles as well as the VOC developed earlier in the DfSS project. In addition to covering the information in the preparation phase, setting the stage for innovation is the time to prime the creativity juices within the team. One way to accomplish this is to review marketing data about mega trends with respect to the marketplace, technology and competition. Understanding what may be happening in the future can serve to position the team to think of the bigger picture and not just their particular project. This will help the team to begin innovative thinking.

The other very important part of setting the stage for innovation is for the team to review the voice of the customer and understand the specific design challenges that are being presented. These challenges will serve as the impetus for innovation and will also dictate the specific creativity tools and techniques to be deployed. Breakthrough innovation is based on a need. The design challenges will provide the need. The facilitator will not only lead the kaizen event, facilitating the team through the requirements but will adopt tools, techniques and formats that enable the team to accomplish the deliverables of setting the stage for innovation.

3. Divergent Innovation

Divergent innovation is the next phase of running the innovation kaizen event. Many professions require people to develop solutions to problems. The experiences gained while developing these solutions establishes physiological inertia. While this inertia is good for replication of results, it often produces blockages or blinders when looking for other ways of doing things, creating a sort of tunnel vision that limits the possibilities for new ideas. This is a fundamental finding from the results of Dr. Land's study from above that outlined the more experience and education that a person has, generally the less innovative they are. This type of problem solving requires convergent thinking. Convergent thinking brings together information focused on solving a problem in a linear, focused manner, narrowing thoughts until a conclusion is made. This is a common approach taken in many DfSS project teams, especially if the team has a significant amount of technical expertise. Without leveraging a process, the teams rely on previous experiences and knowledge (convergent thinking) rather then searching for new ways of doing things.

Divergent or creative thinking is the opposite of convergent. Divergent thinking requires an individual to think laterally at a problem and look for new paths or entry points outside the psychological inertia. Divergent thinking is where creativity occurs and is often called 'outside the box' thinking. If there is no divergent thinking then true breakthrough innovation is difficult to achieve. However if there is no convergent thinking, it is difficult to develop solutions from the creativity. The systematic innovation process involves using divergent thinking to find alternate entry points into ones knowledge and then to use convergent thinking to evaluate them and drive toward a solution. The systematic innovation process is not linear but is cyclical with cycles of creative divergent thinking followed by controlled convergent thinking followed by additional cycles of divergent thinking until a final solution is found. This cyclic process is followed thru numerous times through out the systematic innovation process.

Therefore, the first step in innovation exercise in a kaizen event is to apply divergent thinking to the major design challenges. Rather then just searching for undirected open innovation, the systematic innovation process leverages the needs from the design challenges outlined above. Each specific challenge will target a different entry point for innovation. The specific challenge will dictate the creativity / innovation tool used out of a large number of tools available. The process is flexible to apply whichever tool the team is comfortable with that meets the specific challenge. The facilitator's role is to identify the best tool for the particular challenge and to facilitate the team thru the use of the tool. The systematic innovation process is different then other more prescriptive processes because it is flexible to adopt which ever tool is most powerful for a particular challenge. The key is leveraging experienced facilitators that have a broad understanding of the creativity and innovation tools that are available to choose from.

The output of the divergent innovation phase is a collection of discrete innovation bits. These are creative ideas that may not be concepts but are excursions into creative ideas surrounding the design problems and the design itself. They may be a brief idea about a part of the design or feature and are rarely complete concepts at this point. They may be in the form of sketches, written descriptions, notes and hand made models. The fact that the idea is not complete, comprehensive or well articulated is not a problem. The purpose is to generate a large number of discrete bits of innovation which will be pieced together to form concepts in the convergent innovation phase. They key to breakthrough innovation is the volume of the innovation bits. In many cases the facilitator will divide the kaizen event team into sub-teams and have them pursue innovation bits independently, leveraging different tools and challenges. This enables each group to come at the design from a different entry point increasing the breadth and depth of the ideas.

4. Convergent Innovation

The next phase of running a systematic innovation kaizen event is the convergent innovation phase. This is the place in the process where all of the innovation bits will come together to form a number of set concepts. The teams take all of the work from the divergent innovation as an input and strings together these bits using creativity tools that are more convergent in nature. As mentioned above, often there will be more than one sub-team working on generating innovation bits independently and these teams will stay together for the convergent innovation phase. Each team may also leverage different tools to aide in their systematic convergence of the concepts. The concepts may range from incremental to complete breakthrough. The teams are encouraged not to pass judgment on the concepts at this point and to include all ideas. Even if a particular concept is not selected for the current DfSS project, it may serve as idea for future projects.

After each sub-team develops a number of concepts, the collection from the entire kaizen team is brought together and affinity grouped. Often further hybridization of concepts will occur as one team's ideas spur on ideas from another team. The key to effective convergent innovation is tool selection and effective facilitation. There is a fine balance with allowing the team to think openly while still following a process. This is the key role of the facilitator.

5. Concept Hybridization and Ranking

The next phase of running a systematic innovation kaizen event for producing innovation on demand is the concept hybridization and ranking phase. This is where the entire DfSS team will load the top concepts into a matrix and rank them according to the customer key characteristics from the VOC. Invariably there will be different concepts that are better at fulfilling certain key characteristics. This is where additional hybridization and innovation may occur. This is where new concepts begin to emerge by taking the best features from all of the concepts. There are often a number of cycles of hybridization, followed by control convergence on concepts and ranking of the new concepts.

If there is more than one concept that shows potential, the team may decide to bring more than one concept forward to the embodiment of design. The practice of pursuing more than one concept at a time is sometimes called set-based design. This practice allows the team to carry two or more designs forward in the design process within the DfSS project so that additional development can be completed prior to passing judgment on the validity of the concepts. This option is often taken when one of the ideas represents a more radical, potential breakthrough solution with a higher risk of implementation. Often the design team will augment the more radical design with a more incremental design in order to mitigate the risk and serve as a backup. Pursing a set-based design increases the complexity of the embodiment of the design portion of the DfSS project but provides the opportunity to gather more information before any decision needs to be made. Selecting the ideal concept(s) to pursue is critical to the continuation of the statistical design and optimization portion of the DfSS roadmap.

6. Concept Detailing

The final phase in running a systematic innovation kaizen event is the concept detailing phase. This is the part of the process where formal documentation of the event and all its contents take place. This phase is typically carried out by the core team of the DfSS project at the end of an event. It is important that the core team complete this phase as close to the end of the event as possible while all of the concepts and ideas generated are fresh in the minds of the team. The team will develop sketches, drawings, written descriptions, specifications and any other document required to properly capture the concepts selected as well as those not selected for future consideration. During this documentation the concepts may even be further developed as the team has more time to consider the design. Proper documentation will enable the team to refer back to any ideas for the current program or any future program. Without proper documentation, some of the details of the ideas may be lost.

Summary

The systematic innovation process is a proven method for delivering innovative concepts within a DfSS project that are based on the customer wants and needs. The systematic innovation process is a collection of methods, tools and techniques packaged in a manner that enable breakthrough innovation by DfSS project teams. The process starts with proper preparation and setting the stage for innovation. Next the process deploys a series of divergent followed by convergent innovation cycles. Any concepts that come out are then hybridized, ranked and detailed. An effective way to operationalize this process is in the context of a kaizen event. The entire systematic innovation process allows DfSS teams the ability to deliver the front part of the product development process, delivering products that competitively position their organizations in the marketplace.

Industry is searching for a universal systematic approach to innovation within DfSS projects. There is a need for a process that will do for innovation what Six Sigma DMAIC has done for continuous improvement. Huthwaite has offered the Innovation Cube (Huthwaite, 2007), Silverstein has offered INsourcing innovations (Silverstein, 2005). There are a number of other methods that have been formally and informally documented and are being used by DfSS project teams; however none has emerged as a universally applicable and accepted process for producing innovation on demand. The systematic innovation process is an attempt at documenting a process that fulfills this gap. The process introduced has borrowed key steps and tools from many processes and has packaged them in a useable format that is flexible in its usage of tools and adaptable in its applicability. The systematic innovation process lays out a fundamental process to be followed with the flexibility to apply whatever tools are necessary by the project and are familiar by the facilitator. It remains to be seen if the systematic innovation process will take the place of a universally accepted process but it has proven to be very helpful in many DfSS projects to date.

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