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User-driven Innovation for Industrial Environment in China: Opportunities and Challenges

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Abstract: Multinational corporations such as Siemens are facing considerable innovation challenge in China. They need to respond quickly to rapidly changing demands of the growing Chinese customers in the midst of strong competition from local newcomers with disruptive threats as well as from other established global players. To benefit from these growing opportunities, Siemens Corporate Technology China developed a practical innovation methodology by integrating the existing best practices of the user-focused processes (e.g. Design Thinking) in a new way to adjust to the requirements of industry and China. In addition, related infrastructures for coaching and team building have also been created to support the innovation process. The methodology and the coaching resources have been used to run several projects of real business value to Siemens China and beyond. The paper highlights the learning on the critical aspects of the methodology for project success as well as for innovation training and coaching with a focus on unique requirements in China.

Keywords: Innovation; Idea; China; Siemens; Industrial; Design Thinking; Needfinding; Prototyping; Extreme User; Implementation

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1. Introduction

Globalization has created great opportunities and challenges for multinational companies such as Siemens, specifically for the emerging markets such as China. The opportunities in China for Siemens lie in leveraging its' global infrastructure and technology strength, the brand and quality recognition, and the partner relationships and process excellence. The challenges are in responding quickly through innovation to rapidly changing demands of the growing Chinese customers in the midst of strong competition from many local newcomers as well as established global players. Govindarajan and Trimble in their recent book "Reverse Innovation: Create far from home, win everywhere" (Govindarajan & Trimble, 2012) highlighted recent trend of upstream migration of innovation from the developing world to the developed world thus changing rules of innovation and growth. To take advantage of these opportunities resulting from the changing environment, Siemens China is focused on building processes and talents for speedy innovation to address need-driven opportunities for the local and global market. Specifically, Siemens Corporate Technology (CT) China has initiated an effort to build an innovation community using a systematic user-focused innovation methodology, based on Stanford University's and IDEO's Design Thinking approaches (IDEO, 2011; Meinel & Leifer, 2012). The methodology is applied through execution of real business projects by multi-disciplinary project teams. The goal is to foster local innovation talents while producing business value at high speed with high success rates.

Innovation in the industrial world demands value creation that can be measured in terms of return on innovation investment. The output could be in many forms such as new products/solutions, intellectual property, R&D publications and presentation, creating knowledge base and a R&D community to trigger sustainable innovation through changes in mindset. But the most important measure often times is in terms of revenue generated through commercialization of new products and solutions. Innovation has been described in the literature (Govindarajan & Trimble, 2010) by a simple equation:

Innovation = Ideas + Execution

With focus on user-driven need-based innovation, we slightly modify the equation to

Innovation = Need-based Ideas + Implementation for Commercialization

where the right side *represents the value creation through new products and solutions.* This approach is similar to the Innovation Model described in another recently published book on this topic (Fitzgerald, Wankerl, & Schramm, 2012), where the authors described three key elements to the innovation process: technology, market application, and implementation – all three of these elements are intimately connected to each other via iterations throughout the innovation process. In the equation described above, one can relate "need based ideas" is where technology and market meet. The key in Fitzgerald et. al. model is that the implementation challenges need to be addressed right from the beginning of the innovation processes and must be addressed iteratively as the ideas are generated.

There are little arguments about the fact that the key challenge in the innovation process in an industrial environment is to get beyond ideas and create a path for implementation and commercialization. To be successful, one must take into consideration the business constraints and rules as integral part of the process. The idea is to create a "path" to get across the so called "Valley of Death" (Ford, Koutsky, & Spiwak, 2007) in the innovation sequence with higher success rate (see Figure 1). This transition is difficult because the factors that are critical for innovation and idea generation are highly uncertain and ambiguous; in this space, failure is accepted and is often encouraged as a learning process. Business side, on the other hand, is focused on application and commercialization – their success is based on a high level of performance predictability. Accordingly, uncertainties and failures must be minimized or eliminated, thereby creating a tension resulting from fundamental differences in goals and objectives between the two sides of the valley.

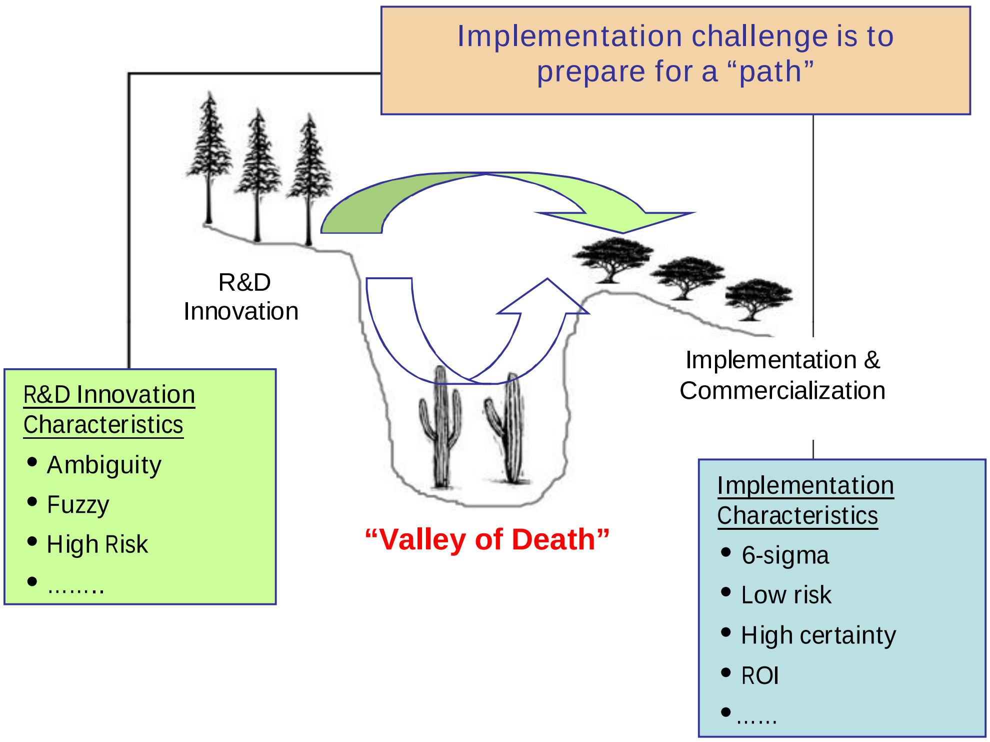

Figure 1: Valley of Death in the Innovation Sequence (Ford et al., 2007).

To achieve the desired goal for innovation and commercialization, Siemens CT China adopted and adjusted Stanford/IDEO Design Thinking approaches for the industrial environment and constraints in China, and accordingly named the method as "Industrial DesignThinking in China" or i.DT. Dr. Arding Hsu, Senior Vice President and Head of Siemens Corporate Technology China has acted as what Scott Anthony (2012) refers to as the "Corporate Catalyst" and helped create the nucleus to start innovation effort in China. Since 2011, a core innovation training and coaching team has been formed in CT China and a dedicated innovation space has been created to support the newly formed group called Integrated and Disruptive Innovation Center (IDIC). To date, several focused projects have been run in IDIC in collaboration with some of the key Siemens business units using i.DT methodology. Renowned consulting teams from Boston-based Innosight and IDEO Shanghai were earlier external partners to kick off the effort. In

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addition, since 2011, IDIC has continued to collaborate with the Center of Design Research (CDR) at Stanford University to ensure implementation of best practices from the academic theories and principles, as well as bring "outside the box" thinking in the application of the i.DT methodology.

Although there are many innovation activities in progress in China, both in multinationals and in local companies, very little of the details of the methodology used and innovation environment are publicly available. The Siemens China effort, described in this paper includes discussions of critical aspects of the i.DT methodology through examples of two representative IDIC cases. We also discuss key learning opportunities and challenges of our innovation experiment, both for project success and for innovation training. We believe that the methodology and the approach can speed up "not-me-too" (i.e. not just an incremental improvement of what is already available but products/solutions with unique selling points) and need-driven innovations in China. But we show in this paper that it is not only the methodology and training resources, but also the team, the team structure, and senior management involvement are critical factors for success.

2. Industrial DesignThinking in China Methodology:

Since i.DT methodology is built on the IDEO and Stanford Design Thinking approaches, we start briefly with the basics of IDEO and Stanford methodology. In order to emphasize the Human Centered Design approach, IDEO transferred the acronyms of HCD to describe the most important aspects of the methodology (IDEO, 2011):

- **Hear (H)**: During the Hear phase, the design team collects stories and inspiration from people through field research.
- **Create (C)**: In the Create phase, the team translates what they hear from people into framework, opportunities, solutions and prototypes. During this phase, the team moves together from abstract thinking in identifying themes and opportunities to concrete solutions and prototypes.
- **Deliver (D)**: The Deliver phase begins to realize solutions, through rapid revenue and cost modeling capability assessment and implementation planning. This helps to launch new solutions into the world.

The HCD phases of IDEO Design Thinking process are shown in Figure 2.

The Stanford Design Thinking approach that we selected (Meinel & Leifer, 2012) is focused on ways of a) finding and b) delivering ideas that sell. The approach is highly "adaptive and evidence based versus theory centric". The process emphasizes quick iterations through needfinding and seven well-defined prototyping stages including feedback to create insights and eventually converge to a solution of choice.

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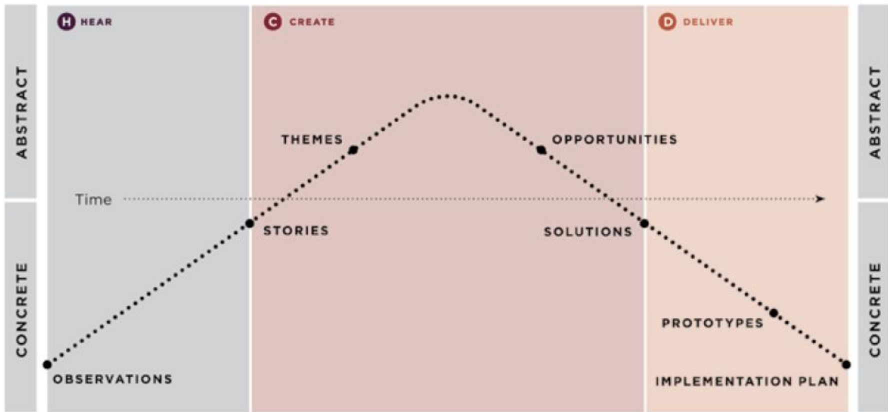

Figure 2: The Hear, Create, Deliver phases of the IDEO Design Thinking process (IDEO, 2011)

The Siemens China i.DT process, shown below (Figure 3), is built on these two approaches, and incorporated the concept of "Job-to-be-Done" as described by Christensen et. al. (2007), as a key starting point for all projects. In principle, i.DT is an integration of the best practices of existing user-focused innovation methodologies in a new way to adjust to the requirements of industry and China.

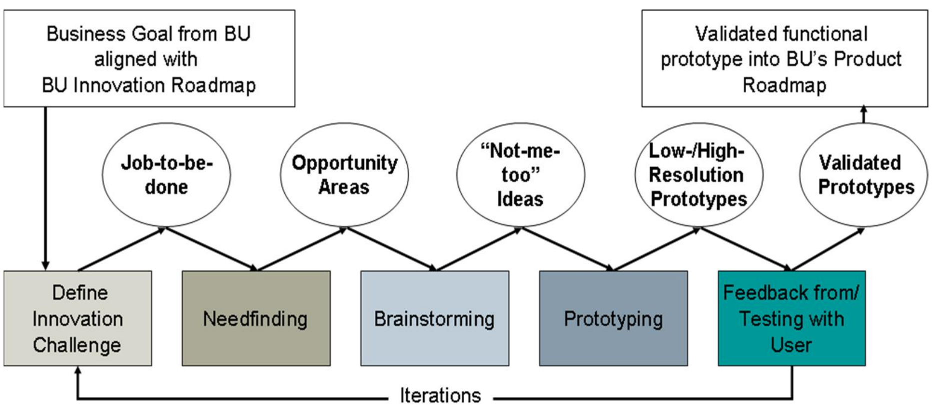

Figure 3: The process steps and expected outcomes for the i.DT methodology.

The i.DT process typically starts when a business unit (BU) defines a project goal which is often described in terms of a product or solution. The teams' first action item is Define Innovation Challenge (rectangular box) with the output of "Job-to-be-Done (JTBD)" (elliptical box) in user terms rather than as products or solutions. The power of JTBD in terms of opening up innovative thinking has been described in detail by Christensen and others in several publications (Christensen et al., 2007; Christensen & Raynor, 2003; Silverstein, Samuel, & DeCarlo, 2009). In i.DT process, as we will see in subsequent discussions, starting with a good JTBD statement in user terms is critical for going beyond incremental opportunities. The JTBD often determines the innovation space and scope within the industrial constraints and therefore the possibilities to create surprises. If the scope is too narrow, the expected results would be incremental; while too broad a project scope is detrimental in focusing and achieving a meaningful target. Note that JTBD is shown in Figure 3 as part of the i.DT iterative loop meaning that the statement does not have to be rigid and fixed through the project duration, but it may evolve and be refocused through the subsequent i.DT steps based on a clear project eco-system and identified key stakeholders.

Several action items (e.g needfinding, brainstorming, prototyping in four distinct stages, and feedback from / testing with users) follow "Define Innovation Challenge" step, with defined expected outcomes. Needfinding through observation and interviews of end-users and other stakeholders in the project eco-system, and specifically with "extreme users", is the critical starting point of the main iterative loop that runs in combination with brainstorming, low-resolution quick prototyping and testing with stakeholders. The output is obtained in terms of insights to produce "opportunity areas" and "not-me-too ideas". At the end of the iterative loop, a "validated functional prototype" (technical feasibility) is developed that is expected to meet the requirements stated in the JTBD (user desirability) and providing a tangible solution with a customer value proposition that is attractive to the business unit for a continuing activity for implementation and commercialization (business viability).

The steps in Figure 3 are shown in a linear fashion, but needless to say that the process is highly non-linear and must be flexible in order to respond quickly to unexpected outcomes, natural to the innovation process. Thus one can interpret the steps as "tools" of an innovation toolbox that should be used and exploited whenever deemed appropriate in the whole process, to maximize their benefits to create innovation.

A few other aspects of the process that are general in nature, and belong to all steps in i.DT, are "storytelling", "benchmarking" and "multidisciplinary thinking". These skills are integral part of innovation, and therefore strongly related to i.DT training (described in Section 5). Storytelling is a skill to get maximum value through communications e.g. with users to receive feedback and with management to get resources and support. Benchmarking asks the team to learn from the best/worst practices of not just classic competitors threatening market-share, but also seemingly unrelated domains with a context-shift mindset, (e.g. a fast food service process could be a benchmark for setting up high-volume processes in Chinese hospitals for well-developed health care procedures such as heart angioplasty or brain stroke care). Multidisciplinary thinking allows the team to go beyond their domains, and bring integrative horizontal thinking by connecting the dots in a broader scope offering opportunities that may not be available in one dimension.

Critical aspects of step by step adoption of the i.DT process for two representative IDIC cases are highlighted in Section 3. Subsequently the challenges and opportunities from the lessons learned are discussed in Section 4.

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3. Examples of i.DT Cases in Siemens CT, China

The projects to date in IDIC were selected largely from existing research and development projects in Siemens China with particularly strong links to business units and business needs. Four teams from different technology fields were working in parallel on project topics of the involved business units. The project duration was four months. The teams typically consisted of a team leader with 2 to 4 team members. The team members generally spent around 50% on their specific innovation projects because engineers' time was split amongst multiple activities (as is often normal in an industrial environment) due to strong demand for their expertise and experience. IDIC facilitated the knowledge transfer of the methodology through weekly trainings as well as hands-on-support in applying the methodology in the execution of the projects through coaching and closely working with teams.

We briefly describe below two representative projects to highlight the first part of the innovation equation i.e. the idea generation process through i.DT. The focus in this section is to describe the critical steps to develop one or more tangible "Functional Prototypes" that were used to demonstrate a compelling value proposition to the Siemens business units for possible product considerations. The challenges and opportunities related to the second part of the innovation equation i.e. idea implementation, will be addressed in Section 4.

3.1 Case 1: CEEB – Cozy Energy Efficient Building

The business goal defined by the customer in this project came from one of the largest Chinese Corporations. The stated goal was to provide an energy management solution to increase efficiency and reduce energy consumption in buildings through improvement of existing IT tools, processes, and resources. The goal of the corresponding Siemens business unit was to be able to create expanded business opportunities built on existing Siemens building management infrastructure. The team explored the eco-system of energy management solutions and saving opportunities in building infrastructure to redefine project goal in terms of JTBD for a user and/or customer.

The JTBD statement for the CEEB project was described as: "Offer the customer an expanded business opportunity by shifting from the traditional *centrally controlled energy management* to an *energy allocation solution.* This should be accomplished by' taking into account the needs of all users and stakeholders in buildings to increase building occupants' comfort as well as to decrease energy cost. This shift in emphasis to customer's need (increased business opportunity) instead of products or solutions was a key to ideas generated in this project. The i.DT process demands this change in the project definition as a means to improve chances of not-me-too innovation potential.

To achieve the targeted JTBD goal, the team initiated an intense needfinding process for insights and understanding of the opportunity areas offered specifically by the "extreme users" (see Figure 4). The concept of extreme users is critically important to the i.DT methodology. For example, the conventional mainstream users for the building energy management are building operators, as shown in the top of a typical bell curve distribution in Figure 4. Although the building occupants e.g. the office workers or in a residential situation, the apartment dwellers, have a real stake in the use of energy and the resulting comfort, it is rare that they are involved in the decision making process for system implementation. The office workers and the apartment dwellers are defined here as the extreme users – they are often the ignored but critical stakeholders who may significantly influence (as we have seen in this project) and help develop meaningful and winning solutions through their unmet needs.

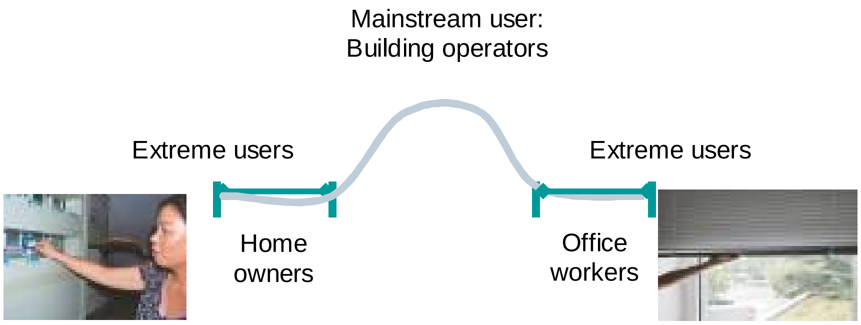

Figure 4: Observation of extreme users in needfinding to discover critical hidden needs.

Along with the needfinding process, the team simultaneously started to develop first groups of low-resolution/low-cost prototypes to explore possible ways to find solutions to the identified need. For every prototype, the team requested feedback from peers, users and other stakeholders and learned from the basic critical assumptions in the JTBD statement. The learning and knowledge gained from iterative prototyping and feedback set the stage for subsequent steps in the process.

For the CEEB project, the team went through four different prototype stages with iterations of needfinding, brainstorming, prototyping and testing. The first two stages (see Figure 5) represent the diverging phase for exploring different possibilities to satisfy the identified need. The last two stages make up the converging phase where the team needs to decide the best possible solution in terms of user desirability, technology feasibility, and business viability. To speed up the whole cycle, the teams must start with low-resolution/low-cost prototypes for quick feedback from peers and users, to high-resolution prototypes for functional testing and validation. The prototyping details for the CEEB project, as shown in Figure 5, are described as follows:

Diverging Phase Concepts

- Prototype Stage 1:
  Possibility to provide feedback via instant messenger showing that office workers highly value direct interaction with the building
- Prototype Stage 2:
  Temperature zones by floor level to test unusual energy saving concepts: The learning from this prototype eliminated unsuitable ideas at an early stage thus allowing focus on winning concepts.

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Converging Phase Concepts

- Prototype Stage 3:
  Low-resolution prototype on paper of a mobile application for personalized energy management for quick feedback and improvement.
- Prototype Stage 4:
  High-resolution prototype programmed for an Android smart phone of the mobile application for personalized energy management for functional testing and validation.

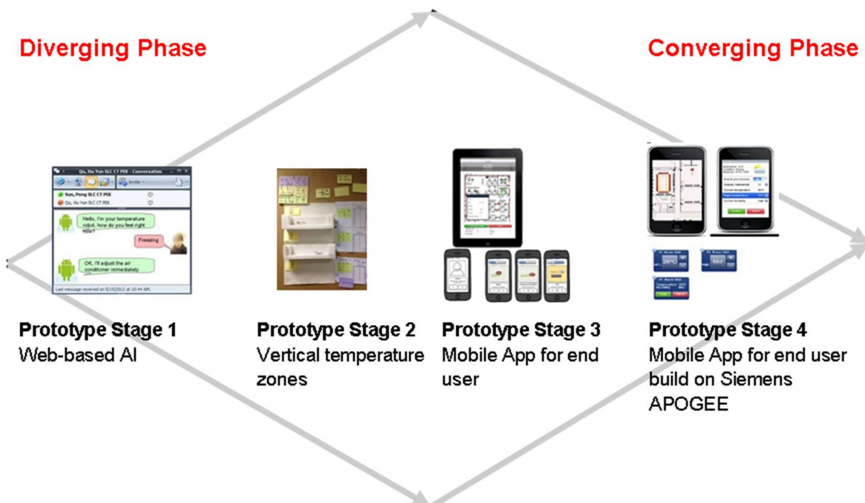

Figure 5: Four different prototype stages from diverging to converging for providing a personal energy management solution.

Finally the team developed a "Validated Functional Prototype" for personal energy management solution via smart phones for building occupants to deliver personal preferences with intelligent decision-making capability. The goal was to optimize user demands and seamlessly integrate the mobile application with Siemens APOGEE® Building Automation system. The value proposition of the solution is an offering for personalized comfort for the end-user as well as an increased energy saving for the target user such as the building operators.

3.2 Case 2: DigitUp – Miner Location System

Initial business unit goal for this project was stated as: "Find a solution to locate miners in China based on existing Siemens industrial communication products." The solution for this project was rather straight forward for the team; however, it could be easily copied and duplicated. The process step of Define Innovation Challenge using the eco-system and the Job-to-be-Done analysis shifted the project target from miner location to miner safety with a stated JTBD: "Define a comprehensive solution for identification, location

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and communication of people and equipment in mines." This shift created an opportunity space for Siemens to produce products and solutions with unique selling points and with sustainable technical advantage.

To identify opportunity areas from "hidden" user needs, the team visited a coal mine for onsite observation and interviews. Additionally, they created a persona (see Figure 6), representative of a typical user in order to get a deeper understanding of his/her needs. Just through making the user tangible with original minor equipment in China, several assumptions could be tested. The shift leader of the miner team was identified as one of the extreme users in this project; he/she was responsible for the security, safety, and the operation details of all miners in his team. Having empathy with the persona of the shift leader, the team understood that location of miners after a mining accident is necessary (particularly for the rescue team outside the mine), but more important for the shift leader and other miners is the ability to communicate to guide and support the rescue operation.

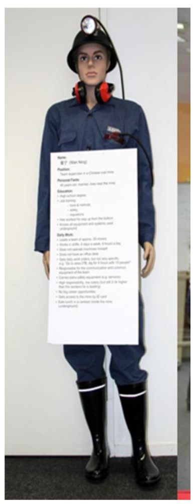

Figure 6: The persona of a shift leader in miner safety project.

Based on this broader understanding of what the JTBD for this project should be, the team started their i.DT process. The resulting prototype concepts are described below (see Figure 7)

Diverging Phase Concepts:

- Prototype Stage 1:
  Low-resolution prototype of a warning solution for miner with headlamp light
- Prototype Stage 2:
  Low-resolution prototype of a flexible wireless LAN platform with the potential to be used by local System Integrators to develop applications for coal mines.

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Converging Phase Concepts:

- Prototype Stage 3: Low-resolution/low-cost, rapidly assembled prototype of "Personal Wireless Lifesaver for Miners" that used existing head lamp pack as a power supply for sound, and flash lights as alarming indicator for miners.
- Prototype Stage 4:
  High-resolution functional prototype of the "Industrial WLAN Module Platform with the Personal Wireless Lifesaver for Miners"

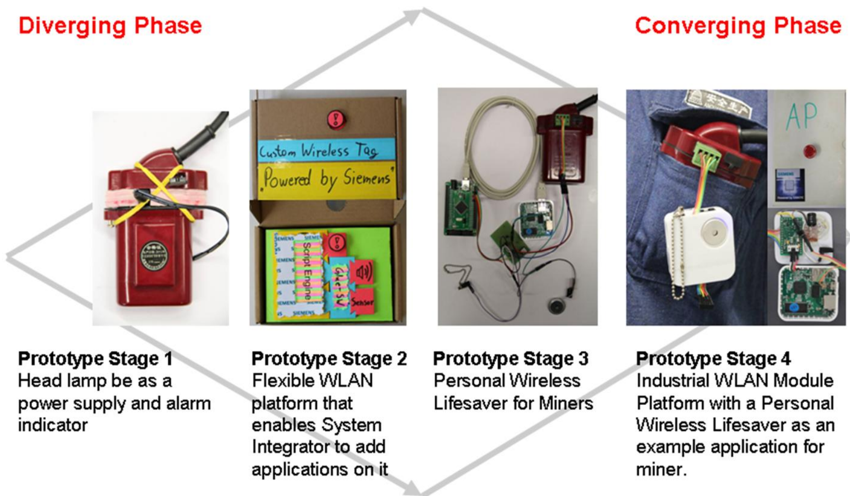

Figure 7: Four different prototype stages for DigitUp project.

Once again, the DigitUp project showed that the process that started with the re-definition of JTBD followed by needfinding with the help of extreme users and rapid prototyping for learning focused on user needs, yielded an unconventional not-me-too solution for business unit consideration.

The i.DT methodology used in both projects differed significantly from traditional technology focused R&D projects. The significant steps are:

- Define a Job-to-be-Done statement as a problem to be solved for a user and/or customer who does not have a good existing solution under specific circumstances
- Use of extreme users for inspirations for unconventional ideas.
- Iterative and quick low-resolution prototyping for learning and redirection. This allowed development of tangible functional prototype concepts for business consideration in 4-month long projects.

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4. Lessons Learned – Opportunities and Challenges

Direct comparison of project outcome with and without intervention of a specific innovation methodology is difficult to quantify without a randomized trial of similar projects run by similar groups with and without i.DT. In the absence of such data, indirect evidences can be used over a period of time in terms of increased patents, industry publications, project transfers to business units or increased "new products" coming from such activities after the innovation methodology has been introduced. IDEO, with its long-term experiences in Design Thinking with their clients has shown many cases of "innovation" in a number of different business areas. Stanford has similar anecdotal data to show the value of Design Thinking in student projects. For IDIC, the project data is limited. But we attempt here to make some educated and systematic judgments regarding our learning on the impact of i.DT in Siemens China projects and project teams.

The effect of i.DT intervention in IDIC cases, as described in Section 3, showed that for these specific projects, the project methodology, coaching and related management support resulted in ideas in a very short time period, with value propositions of considerable interest to the Siemens management. For the CEEB project, the traditional target of having "a better building control system with increased efficiency and reduced energy consumption from an IT perspective" moved up to a significantly higher level of opportunity i.e. "maximize energy savings and personal comfort in buildings". In the DigitUp project, the goal changed from "locating miners" to "improving safety and security for mines and miners", which eventually resulted in broader technology solution options built on existing Siemens technology and platforms. The user-focused i.DT methodology was crucial in developing such insights and ideas in a 4-month project development cycles, for practical and potential business value to Siemens.

4.1 Ideation Challenge: Role of Project Team

We have so far discussed the i.DT methodology and related training and coaching support activities in relation to ideation. Evidently, coaching and methodology cannot work by itself without the presence of skilled receivers i.e. the project team. Intervention of an innovation methodology such as i.DT impacts teams in ways that can be represented by an "S-curve". The S-curve framework has been used in many fields including descriptions of technology (Christensen, 2000) which goes through the introduction, growth, and maturation. Figure 8 represents the learning S-curve in which i.DT learning is plotted against training time. Like any other training process, there is a threshold until the initial learning is completed allowing to grasp the concepts and to develop sufficient knowledge and expertise to become an effective user of the methodology and i.DT principles (represented by the flat part at the top of the curve). The threshold is determined by coaching resource and skill as well as teams' and team members' background and capabilities to learn and absorb the process. Since each team member does not have the same learning curve, project success often depends on the fastest learner and his/her ability to drive the team toward the project goal. Thus, one of the key factors in i.DT process is to focus on building Team Leaders and Managers who can then act as the Innovation Drivers for the group. This is in contrast to the experience in research done in Stanford University, as discussed in a paper on "Art and Science of Design Team Formation" (Kress & Schar, 2012) using masters-level students from nine universities in eight countries who collaborated on projects over a period of 8 months.

This research showed that a single leader team is not an optimal model to produce superior results; instead, a shared leadership in the team fosters a sense of shared ownership thus encouraging engagement from all members and facilitating goal alignment.

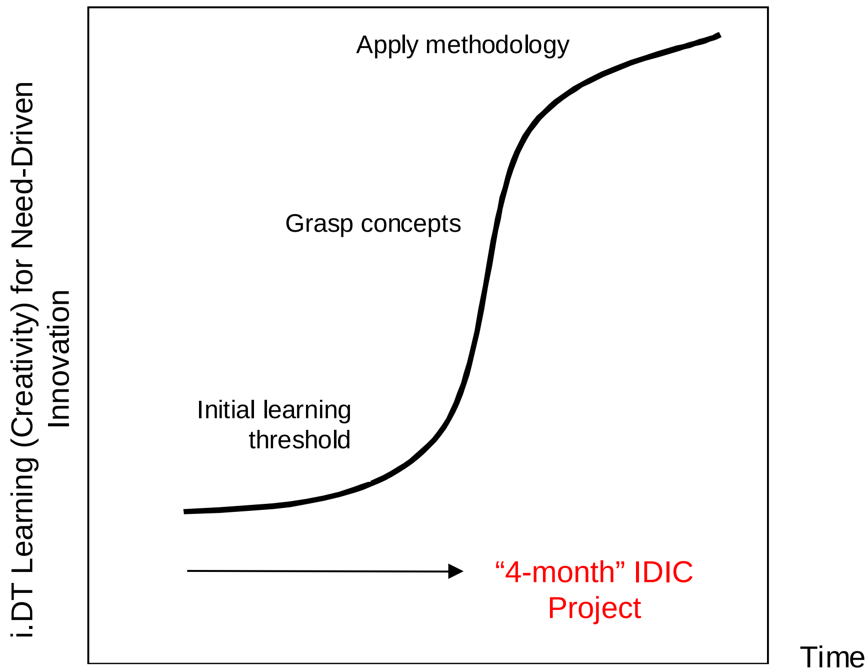

Figure 8: i.DT Learning S-curve

The differences in approach and choice in IDIC lie in the established hierarchical structure in industry, where accountability demands clear definition of responsibilities. In contrast, in the university classroom, learning is the key driver for projects; all team members are peers and there are fewer constraints (typically imposed by organization and business units) in terms of project deliverables. Thus the student teams have the ability to drive projects in the white space with an open mind, and an ad-hoc team structure with no fixed leader can work well to get maximum benefit of each member's individual talents and skills.

The goal of the overall Siemens CT China effort is to bring the independent innovative thinking process to the individual team member level. Therefore, the team leaders must act as the nucleus to drive the innovation thinking through the ranks; this requires superior collaborative skills to bring the best out of individual team members; and motivate them toward a common goal. This is particularly important in China, where team members often depend too much on their leaders for decisions and directions.

The projects need to have a common goal (i.e. a good JTBD statement) and collaboration amongst team members to get optimal results. But innovation projects, by nature, create tension and stress because of inherent uncertainties and constant need to make choices through learning, often times through failures. In fact, the absence of tension in a project could be an indication of a lack of team interest at the individual level and therefore needs attention from coaches and management. The tension needs to be encouraged in a controlled manner through brainstorming and other interventions so that the team is looking at all options with an open mind.

4.2 Innovation Implementation Challenge: The Role of Senior Management

Idea generation in i.DT is only part of the equation for business value generation. As mentioned in Section 1, the real challenge in the industrial environment is to go beyond ideas to implementation and commercialization. Using the S-curve framework again (see Figure 9), one can build an innovation strategy based on potential *"Return on Innovation Investment"* through 1) idea generation and 2) by creating new products/solutions via early preparations for building a path for eventual implementation and commercialization by business unit(s). It should be emphasized though that idea generation and implementation should not be viewed as linear processes, but they should be addressed iteratively from the start of the project to have the best chance to get to commercialization. This is consistent with the innovation model proposed by Fitzgerald et. al. (2012); in their model, implementation is considered to be an integral and iterative part of the total innovation process.

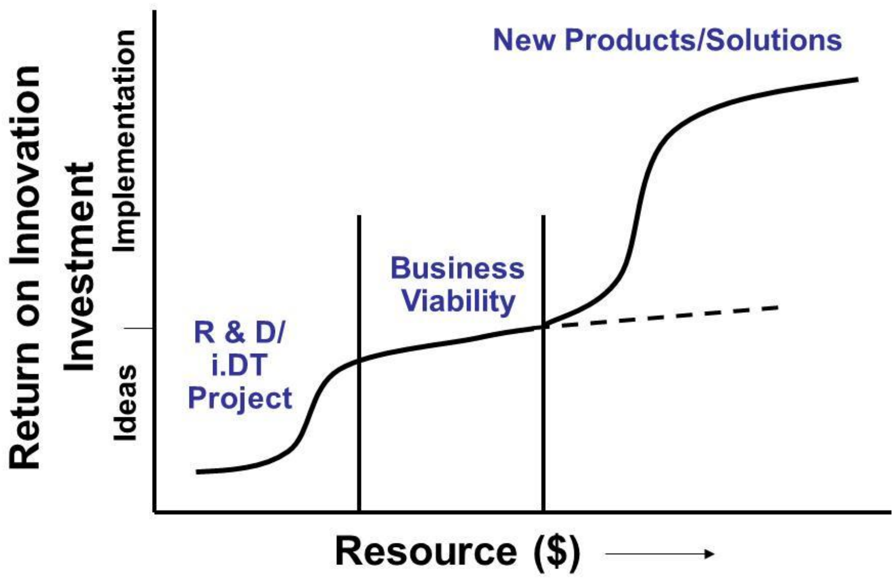

Figure 9 Return on Innovation Investment through Idea Generation and Implementation/Commercialization

The first "S" in Figure 9 represents the idea generation phase. The second part, a near flat region, represents a business viability study (to be done in collaboration with the business unit and the project team) that requires a commitment from a business unit and/or a customer for possible commercialization of project results. Transition to this flat region from the ideation stage is required for any chance of success for the project to create business value through commercialization. Therefore we call this stage the "Innovation Trap" which is identical to the "Valley of Death" described in Section 1. If the ideas cannot get into this viability stage, the outcome could still be valuable to company R&D and management in the form of knowledge gained, publications, patents, and above all, through i.DT trained engineers and scientists, but the project itself cannot add business value as a saleable "new product or solution". Definition of "new" for products or solutions varies widely from company to company, and it may be as simple as a packaging change, or a game changing innovation in the other extreme. But once an agreement is reached regarding what is new, achievement of such business success can be facilitated through correct project selections, and strong links to decision makers from business units. Specifically, pre-established commitments for viability studies from business units to drive "successful" project results are critical to get over the innovation trap.

To get beyond the innovation trap and to the second "S" (Figure 9) that represents the commercialization process with the usual learning curve, one must be able to get support from senior management incorporating R&D, business units and headquarter specifically in terms of selection and funneling of high priority projects through various innovation processes and associated resource allotment. Most companies including Siemens have such processes adopted at the highest level. But the real difference in successful IDIC projects in Siemens China came from, not just the process or sponsorship of projects, but from hands-on active participation of senior management through stage-gate project reviews, and timely support for critical resource and decision making processes. Early and active involvements of the senior management team from both R&D and business units are highly motivational to project teams and could spell the difference between outstanding and average outcome.

The last part of the curve in Figure 9 represents the region of major commitment when approval is received from the business unit for possible commercialization. This is a normal business unit function; however, the innovation team could still be an active participant in a support role.

5. Innovation Training and Coaching in Siemens China

Although project outcome and the business value it produces have the most direct and visible impact to management in relation to application of i.DT methodology, the innovation training and coaching of Siemens R&D managers and engineers in China through real projects is a critical goal for the IDIC team. The training/coaching and the community it builds with i.DT trained managers and engineers have a long-term strategic impact for Siemens to remain competitive in the fast-growing Chinese market.

5.1 Competitive Situation: Diverse Needs and Mass Market in China

a. Speed to Market at Low Cost

The largest disruptive and competitive threats for Siemens in China come from local Chinese companies. The challenge lies in the fact that the Chinese companies often use a model of "innovation through commercialization" (Orr & Roth, 2012) – a very different approach for product introduction than those used by large multinationals. As pointed out in a McKinsey report (Orr & Roth, 2012), the Chinese companies are generally "more comfortable than Western companies to put a new product or service in the market quickly and improving its performance through subsequent generation", as opposed to constant research and perfecting the solution in the laboratory and pilot operations. This approach allows Chinese competitors to do "product launch in a fraction of the time" and at far lower cost that it would take in more developed markets. The quality of the early versions is sometimes questionable, but user feedback allows quick and relevant improvement in subsequent versions. The advantage to the Chinese companies in this model is speed-to-market at low-cost, which is often a determining factor for success in China with diverse needs and a mass market different from most other markets in the world.

Since quality is one of the key strengths of the Siemens brand, and quality compromises in the market place are not acceptable, speed and competitive cost targets need to be achieved through the right processes with the appropriate training, i.DT in China therefore is focused on quick iteration through the steps including fast low-resolution, low-cost prototyping and testing with local users and stakeholders to simulate what Chinese companies do in the marketplace. All IDIC projects are run with strict timelines and targets to achieve results with high quality and speed. Benchmarking of alternative products/solutions and cost innovation, built on Siemens technology strength, are pursued in the i.DT process to achieve a sustainable competitive position in the Chinese market.

b. Knowledge of Local Needs

Chinese competitors often have another significant advantage in their ability to sharply focus on local needs because China is their market. Multinationals, on the other hand, are sometimes slowed down by the complexities of local vs. global technology, product, and market considerations. The Chinese companies are far more well-connected to the growing customer base (specifically the un-served customers) and local systems compared to western companies. This gives them the advantage of faster access to and better understanding of hidden needs, local business rules and relationships, and politics in China; all critical factors for bringing new products to the market place. To compete against this advantage, i.DT training and coaching emphasizes needfinding with the local customers and extreme users in focus. The project teams have to go on-site by themselves and get first-hand impressions and build empathy of local users and stakeholders. In this effort, one key advantage of Siemens over Chinese companies is the ability to leverage its huge global assets. So the IDIC project teams, while learning to unearth local hidden needs through the i.DT approach, are encouraged to dig deep into broad Siemens technology portfolio to create unique integrated solutions for the customer.

c. Multidisciplinary Thinking for Integration and Fusion

The majority of competitive threats from Chinese companies are not due to breakthrough technologies coming from deep-domain experts, but from their ability to provide affordable and good enough solutions demanded by customers by integrating multiple existing technologies using a smart "mix and match" approach. In this "mix and match" process, the integration ability to deliver desired solutions with speed becomes a critical skill for market success. Figure 10 shows the critical aspects for horizontal (implying broad needfinding expertise incorporating multiple domains) and vertical (implying deep technological domain expertise) skills that are required for integration and fusion. Integration and fusion, in this context, means combining existing and/or new technologies as well as the market in a new way to generate value for unmet needs and create unique products or solutions.

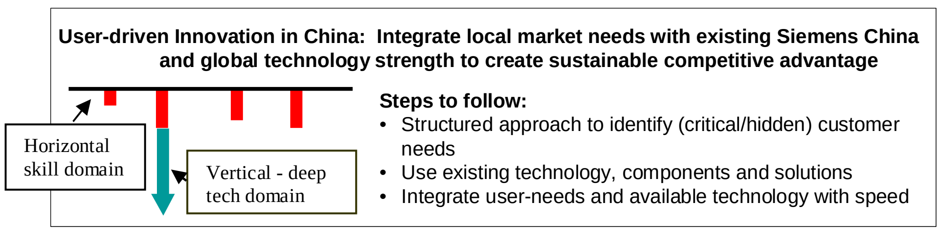

Figure 10: Customer need-driven innovation with integration and fusion of multiple technologies with unique selling point.

Siemens has a fundamental advantage in developing and utilizing vertical skills because of its internal deep technology base, and this focus is maintained within Siemens globally through large R&D investment in core technology. i.DT training and coaching in China is therefore focused on building up the complimentary horizontal thinking skills for innovation. The challenge is to tap into the technology base and create timely solutions when needs are identified for a market located far away from headquarters.

d. Questioning:

Jeff Dyer et. al. (2009) in their book "The Innovator's DNA", described "questioning" as one of the key five skills for disruptive innovators. They noted that questioning, in combination with other behavioral skills such as observing, networking, and experimenting and the cognitive skill of associating, allows the superior innovators to see the connections amongst the questions, potential user needs, and solutions for creative ideas. Questioning is generally considered an advantage for the western education system and companies, where challenging the status quo and thinking of new possibilities are encouraged. To reinforce this skill in the i.DT process in Siemens China, a comprehensive question list has been developed for each of the process steps. Examples of such questions for the first two steps are shown in Table 1. The intent is not to miss any of the key elements and project focus that is built in the methodology. This list is largely methodology focused, and is augmented with project specific questions to include technology and user needs.

Table 1 Examples of key factors and suggested questions in typical i.DT steps – they are the basis to improve innovation skill

i.DT Steps	*Key Factors*	*Questions*
BU Goal	BU Champion, BU participants	• Who provided the BU goal? • Is this person the decision maker/influencer for project transfer? • Is this person an active participant through reviews, project tasks, and other activities?
Define Innovation Challenge -> Job-to-be-Done	User terms rather than in product or technology function, job tree to define actionable focus, visualized eco-system with important stakeholders and their relations	• Is your innovation challenge in agreement with your BU Champion/BU team? • Do you have a job tree to focus on actionable items? What is your actionable "Job-to-be-Done" that will meet your design requirements and your persona's needs? Who are the different parties (stakeholders) in your project and what is their relation to each other (users, customers, decision makers, distributors, NGOs, Government)?

e. Risk Taking, and Collaboration

Traditionally, risk taking and collaboration are strong points for multinationals (similar to questioning). Risk taking requires that one accepts failure as an option, and collaboration means the ability to face and resolve conflict in a positive way. These are mindset changes that can only be achieved with continuous effort with motivation, teamwork, and incentives with support from experienced mentors and managers, and coaching. IDIC therefore selects projects and teams with potential, but not without risk, and encourages multidisciplinary collaboration through the building of an innovation community within Siemens CT China.

5.2 i.DT Mindset: Long-Term Value for Siemens China

The learning S-curve shown in Figure 8 implies that the R&D managers and team leaders in Siemens China learn i.DT methodology, and develop related skills and an innovator mindset to drive the process in their own environment, as well as create inspirations for other groups and teams in China. Needless to say, however, that development of such skills needs practice, and more one uses the skill, better he/she gets in creating value from the process. Conversely, if the training is not used on a continuing basis on real projects, the learning starts to wear off and eventually disappears as a practical skill. The same thing happens to a company when the trained members change jobs, taking away their newly developed skills and expertise, thus adversely impacting the very purpose of building an innovation community and i.DT mindset.

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Recognizing this dilemma, IDIC has focused on building an innovation community in Siemens China to allow "Diffusion of Innovations" to take place in the company, as described by Everett Rogers (2003) in his text book on this topic. The theory of Rogers provides an insight to conditions that may allow our methodology and the desired mind set change to reach a tipping point to drive the process through the R&D and business community in Siemens China and beyond. Rogers divided up the population in five categories in terms of the motivation in the context of change for innovation. These categories, in the order of decreased motivation for change or adopting innovation, are: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. Rogers even offered precise numbers for distribution of these categories in general population. In discussing the diffusion for innovation, Les Robinson (2009) offered a "20:60:20 good all purpose rule of thumb" that puts the innovators and Early Adopters in the 20%, Early Majority and Late Majority in the 60%, and Laggards in the remaining 20% category. Based on this principle, the focus to create a critical mass to reach the tipping point for diffusion of i.DT methodology and mindset should come from the "innovators and early adopters" from the first groups of trained managers and leaders. IDIC has created the nucleus for such a community in which the selected individuals are supporting the continuing IDIC tasks as active coaches and trainers. Through this process this group of leaders brings in their passion and experiences to share with the new project teams. The experience to date in Siemens China is rather limited to draw any concrete conclusion, but it is evident that the effort to create such a community that can drive sustainable innovator mindset requires strong support from Siemens Senior Management with regards to resources and long-term vision. But even with the limited experience, the IDIC experiment shows possible paths to create long-term value in terms of improving Siemens competitive position in China.

6. Summary

To understand and respond to the innovation opportunities and competitive challenges in the growing Chinese market, Siemens Corporate Technology China initiated an effort to build an innovation methodology and related infrastructure for training and coaching and team building to create a sustainable innovation community. The challenge in this effort is to build on Siemens' advantages such as global infrastructure, technology strength, brand and quality, partner relationships and process excellence, and respond quickly to rapidly changing demands of the growing Chinese customer base in the midst of strong competition.

The innovation methodology developed in this activity is termed "Industrial DesignThinking in China" or i.DT. In principle, the i.DT methodology is an integration of the existing best practices of the user-focused innovation methodologies in a new way to adjust to the requirements of industry and China. This is built on the ideas of the "Job-to-be-Done" concept popularized by Clayton Christensen of Harvard University and Design Thinking approaches from Stanford University and IDEO. In this effort, local R&D managers and engineers executed real business projects in collaboration with innovation coaches and trainers, as part of the training and coaching as well as to generate value-added deliverables for the business. The paper describes the experiences in Siemens China with respect to real life challenges of instituting a rigorous innovation methodology and an innovation culture through examples of two projects that were run using the i.DT methodology and local project teams.

Further learning described in this paper relates to key factors for innovation training and coaching in China. The training and coaching need to be focused on key R&D managers and team leaders who can then act as the nucleus to drive the innovator mind set through the ranks. The effort also showed the critical role that senior management plays in motivating teams through the ideation phase, and in particular in catalyzing the implementation process. Active participation of leadership team in the innovation process is a necessity for business success.

The focus on Siemens innovation training in China was on factors determined to be critical to compete in the Chinese market place. These include speed to market at low cost, knowledge of local needs, multidisciplinary mindset, questioning skills, risk taking and collaboration. Furthermore, an effort to build an innovation community within Siemens China has been initiated in order to create a critical mass of innovation drivers to reach a tipping point to drive i.DT methodology and mindset through Siemens China R&D and business community.

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References and Notes

Anthony, S. (2012). The New Corporate Garage. *Harvard Business Review, 90(9),* 45–53.

Christensen, C. (2000). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, Massachusetts: Harvard Business School Press.

Christensen, C. M., Anthony, S. D., Berstell, G., & Nitterhouse, D. (2007). Finding the Right Job for Your Product. *MIT Sloan Management Review*, *48*(3), 38–47.

Christensen, C.M., & Raynor, M. (2003). *The Innovator's Solution: Creating and Sustaining Successful Growth.* Boston, Massachusetts: Harvard Business School Press.

Dyer, J., Gregersen, H., & Christensen, C. (2009). The Innovator's DNA. *Harvard Business Review*, *87*(12), 61–67.

Fitzgerald, E., Wankerl, A., & Schramm C. (2012) Inside Real Innovation,, World Scientific Publishing Co. Pte. Ltd.

Ford, G., Koutsky, T., & Spiwak, L. (2007). A Valley of Death in the Innovation Sequence: An Economic Investigation. A discussion paper prepared for the US Commerce Department Technology Adminstration. *Available at SSRN 1093006*.

Govindarajan, V., & Trimble, C. (2010). *The Other Side of Innovation: Solving the Execution Challenge*. Boston, Massachusetts: Harvard Business Press.

Govindarajan, V., & Trimble, C. (2012). *Reverse Innovation: Create Far from Home, Win Everywhere*. Boston, Massachusetts: Harvard Business Press.

IDEO. (2011). *Human Centered Design Tool Kit, 2nd Edition*. *Retrieved on 24th November*.

Kress, G., & Schar, M. (2012). Teamology–The Art and Science of Design Team Formation. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design Thinking Research* (pp. 189–209). Berlin Heidelberg.

Meinel, C., & Leifer, L. (2012). Design Thinking Research. In H. Plattner, C. Meinel, & L. Leifer (Eds.), *Design Thinking Research: Studying Co-creation in Practice* (pp. 1–10). Berlin Heidelberg.

Orr, G., & Roth, E. (2012). A CEO's guide to innovation in China. *McKinsey Quarterly*. Retrieved September 10, 2013, from http://www.mckinseychina.com/wp-content/uploads/2012/02/mckinsey-ceo-guide-to-innovation-in-china.pdf

Robinson, L. (2009). *A Summary of Diffusion of Innovations*. Retrieved September 10, 2013, from http://www.enablingchange.com.au/Summary_Diffusion_Theory.pdf

Rogers, E. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.

Silverstein, D., Samuel, P., & DeCarlo, N. (2009). *The Innovator's Toolkit: 50+ Techniques For Predictable And Sustainable Organic Growth*. Boston, Massachusetts: Harvard Business School Press.