

Co-creation at the Front-end: A Systematic Process for Radical Innovation

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Abstract—Understanding unmet needs via traditional user innovation techniques is satisfactory within the context of incremental innovation. However, radical innovation, where companies must deal with unforeseen disruptive changes, requires a rather more sophisticated approach. Building on the impact of open innovation, a network of outsiders are invited to co-create innovations in this new era. Therefore, in this paper, we examine groups of persons who possess unique characteristics that can provide insightful information for development of radical innovation, and the best data gathering techniques to use. Multiple case study methodology was conducted to gather patterns of three successful radical innovation projects selected by one of the very few foresight market research consultancies in the world. The empirical findings demonstrate that an interdisciplinary team, comprising experts and extreme users of extreme usage working together, is capable of providing valuable input that leads companies to the discovery of radical innovation. Brainstorming, Delphi interview and roleplaying are illustrated as the best techniques to be used. The proposed radical co-creation process will certainly empower companies to effectively exploit the market opportunities of the open innovation era.

Index Terms—Co-creation, extreme users, front-end of innovation, radical innovation, user innovation.

I. FROM USER INNOVATION TO RADICAL INNOVATION: BEYOND THE COMFORT ZONE

In order to cope with the changing pace of today's market, companies have to competitively innovate and differentiate themselves from others [1]. Most companies search for new business opportunities by analyzing historical data that is widely available. By doing so, they invent new technologies, identify their own core competencies, and examine their competitors in order to come up with new market segments [2]. Unfortunately, many of their rivals can perform the same tasks. Thus, the challenge is who can be first to identify future opportunities to satisfy tomorrow's customer, to get ahead of the competition.

Within the innovation process, the most significant action is at the front-end where companies try to identify opportunities, obtaining and maximizing the benefits of internal and external ideas that lead to new concept offerings [2]. Before a concrete idea enters into the formal new product

development stage, this pre-development phase, namely front-end of innovation, must be thoroughly researched and managed [3]. Studies have shown that companies can improve the value and success probability of such opportunities if the front-end of innovation is managed efficiently and effectively [4].

Nevertheless, unwise management of the process may result in poor definition of customer requirements and unfeasible product concept [5]-[7]. Hence, there have been many attempts to structure the front-end of innovation for more productive results. Among these is user innovation, which aims to integrate users' ideas into the innovation process [8]. Studies have shown positive correlation of customer involvement in the innovation process with the success rate of a product's commercialization [9], [10]. Nevertheless, user innovation has been applied and is most effective within the context of incremental innovation [11], which represents modified development based on a company's existing expertise in technological core concepts and within known system linkages [12].

While companies may be able to rely on these minor enhancements for a while, they need to be prepared for any disruptive changes based on entirely new knowledge and technology that will finally emerge as a cycle of radical innovation [1]. An example is the shift from chemical imaging to digital imaging that required companies to make dramatic changes long in advance in order to be ready for the emerging market demands [13].

Radical innovation involves extremely novel developments aiming to serve a market that does not yet really exist [14]. Companies often fail to recognize this paradigm shift and pay too much attention to existing operations [12]. Exploring this unknown territory and exploiting such opportunities ahead of time is crucial to ensure a company's long-term survival and growth [15]. Therefore, companies must develop their own exploration capabilities to satisfy the emerging requirements of tomorrow's customers.

There have been many arguments as to whether or not the user innovation approach can be beneficial during this front-end development of radical innovation. Some argue that users may be caught in today's context and not capable of generating tomorrow's needs or solutions [16]. Thus, by innovating with users, companies may end up with minor-enhanced offerings that do not create sufficient impact to sustain long-term corporate vision [1]. Additionally, users in general lack the ability to understand and foresee highly sophisticated technology fields [17], while the disruptive technology derived from an entirely new knowledge platform is essential in order to shift away from the existing paradigm

Manuscript received January 12, 2012; revised March 21, 2012. The research presented here was supported by grants from Rachadapiseksompoch Research Fund on the occasion of the 90th anniversary of Chulalongkorn University.

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and enter into the development of radical innovations [13]. Though some users may have certain expert status and be able to envisage near future solutions to serve today's market [18], still they cannot deliver scenarios of the distant future.

Since innovation comes in many forms, ranging from incremental to radical innovation, each calls for a different approach to work with the front-end process of innovation. User innovation may have been proven to be useful within the context of incremental innovation, but radical innovation demands much more than just product users. It needs a whole pool of people, including a team with both internal and external experts, to collaborate and identify distant future scenarios for radical innovations.

II. CO-CREATION: USEFUL OR USELESS IN THE CASE OF RADICAL INNOVATION?

Since the era of open innovation, companies have been leveraging their internal research and development outside their current operations and utilizing the benefit of external knowledge [19]. Moreover, innovation process is now gearing towards the new generation where a network of outsiders is a crucial part of ideation [20]. Via the method of co-creation, innovating with users has expanded its territory to include other groups such as experts and all stakeholders within the value chain [21]. Here, users no longer perform passive roles as research subjects but are actively involved in the creative process of innovation with the help of other stakeholders as well as providing idea generative techniques [22]. Nevertheless, not all users can fulfill this complex task, particularly in a radical innovation project. Certain characteristics of users are required with specially designed techniques to gather data.

In order to address the mentioned concerns, this study has been conducted using the multiple case study method based on the recommendation of [23]. The goals are to investigate groups of persons who can provide insightful information and also to examine data gathering techniques based on patterns of successful radical innovation projects from multiple industries. These projects have been initiated by an industry foresight consulting company that specializes in future research of radical innovation. Founded in 1997, this consultancy helps companies realize and recognize the long term business opportunities approximately ten to twenty years ahead and translate trends and future research into the real world of strategic management. Thus, companies can be aware of discontinuous innovations that may occur and prepare to proactively deal with these disruptive changes.

The three selected projects were proposed by a senior market research consultant who has been deeply involved in the front-end development process. These include:

1) Telecommunication industry: The leading global telecommunication service provider based in Korea is looking for future service innovations for customers in different Asian countries in the year 2020. Since Korea is one of the most technologically sophisticated countries in the world that provides a state of the art information superhighway, they want to keep their leading edge status and pave the way for tomorrow's customers.

2) Consumer products industry: The German company operates worldwide with leading brands and technologies in three business areas: Laundry & Home Care, Cosmetics/Toiletries and Adhesive Technologies. The focused study involves the future of dishwashing detergents. The company is concerned that there might be no need to use such products in the next 20 years due to the possible development of self-cleaning technology. If so, what are the alternatives?

3) Packaging industry: The global leader in beverage can production based in Germany is seeking the future trend of beverage can consumption. They want to be prepared for the future and would like to know what the consumption of cans will be in the next 20 years, so that they can be well positioned to satisfy future global customers' needs.

As stated by [24], the success of an innovation project can be assessed according to a company's predefined goals of development stages. With these criteria, the three projects were defined as successful when the initial innovative ideas had been continued to the next stage of product development. To gather data, an individual in-depth interview with a senior market research consultant and review of the company's publicly available documents were conducted during the month of September 2011. In order to analyze the patterns from this data, content analysis was used to search for common phrasing, words and context.

The next section explains the process of radical co-creation, followed by strategic implications to be discussed.

III. THE PROCESS OF RADICAL CO-CREATION

Both market understanding and technical possibilities are the keys to recognizing new business opportunities when it comes to any types of innovation [25]. However, predicting the long term future of radical innovations requires a rigorous process, as seen in Fig.1, in which each step demands the right groups of persons be involved and specific data gathering techniques be employed in order to bring about future scenarios of the next era.

The first step of the radical co-creation process involves identifying essential aspects of the focused study in order to search for categorizations of the subjects. Next, the impact of both emerging technology and social trends derived from those specified aspects are further investigated. Then, in-depth understanding of extreme users can provide insightful information about possibilities of future markets, which leads to the development of scenarios of future radical innovations. The next section explains the four major steps in detail.

A. Searching for Categorizations

Among the many subjects revolving around the focus study, there are only a handful of key aspects of subject matter that comply with the radical opportunity in question. For example, to explore the usage of dishwashing detergents in the future, they may look at dishes, dishwashing, water, cutlery and kitchens. As for radical service innovations for

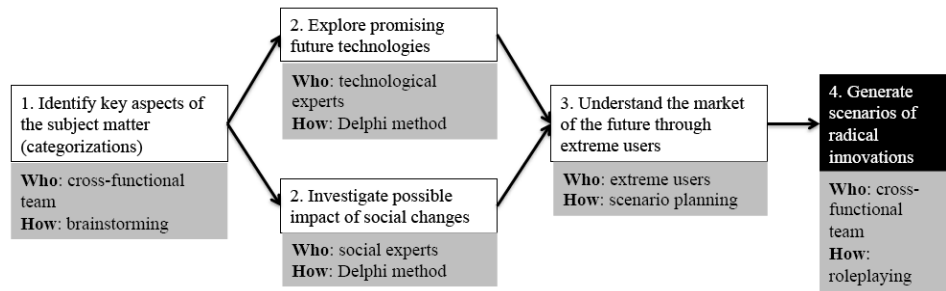


Fig. 1. Radical co-creation process.

telecommunication, future lifestyle, work life, family life and mobility may need further investigation. To search for disruptive changes in beverage can production, the team may need to look at where people drink, why they drink, what time of the day they drink, how they drink, whom they drink with and the beverage itself. Such categories investigated and proposed by the team will be assigned to external experts in the related fields for further exploration. These categorizations will lead to the most effective selection of persons necessary for radical co-creation.

In order to achieve the categorizations of subjects, a team of people with different background knowledge and expertise has proven to be useful [1]. Based on the three cases, developing radical ideas normally begins when the future research questions are raised among the cross-functional team of people from various disciplines. An interdisciplinary team has a broad range of expertise that varies from science, engineering, business, and sociology to art, while also possessing relevant technical knowledge and complementary skills.

The right mix of people is encouraged to trigger learning behavior and team performance. According to [26], moderate diversity of social category, such as age, gender, ethnicity and level of expertise is recommended in order to utilize different perspectives. The brainstorming sessions can follow the approach of [27] to trigger an individual's new ideas or build on the ideas of others while focusing on a specific topic without criticizing other people's ideas. It is also important for the team leader to nurture a high level of collective team identification. In other words, an individual must identify with, and have a sense of belonging to the team, and as a result, feel more comfortable to generate novel ideas. The goal of these brainstorming sessions is to come up with categories related to the topic in question.

A. Capturing Promising Technology and Social Trends

There is consensus that advanced knowledge from experts is crucial to anticipate radical opportunity recognition [28]. Thus, the next step is to involve experts of different categories (identified in the prior step) to explore promising future technologies and investigate the possible impact of social changes. According to the three cases, the use of dishwashing detergent involves cutlery and coating substances. Therefore, expert opinion from material scientists and chemists is extremely valuable. As for the trend of mobile content consumption, in-depth interview with a professor who specializes in digital media and content is crucial to uncover future changes. A sociologist or

environmentalist can be of significant help when the companies search for future behavioral shift in beverage drinking. Companies may also want to convene material scientists and dig into the frontier of materials technology to produce beverage can.

It is noted that these experts may come from various fields ranging from arts and sciences to culture and social sciences. The purpose is to gain maximum understanding of both technology and social aspects necessary to foresee radical innovations. In choosing appropriate experts, [29] proposed a systematic selection of various disciplines and skills of experts from academics to practitioners, government and NGOs. For academics, a review of academic journals will indicate suitable candidates. Business associations can suggest practitioners in the category of investigation, while government departments and NGOs are also able to provide qualified experts related to either technological or social aspects in question.

In terms of data gathering technique, conventionally, companies may refer to typical surveys, focus groups, group interviews, or a combination of these [30]. If a higher innovativeness level of insight is anticipated, ethnographic research could be conducted where companies try to observe attitudes and behaviors of subjects [31]. But these methods are suitable for product enhancement projects rather than radical innovations [32].

When companies want to identify trends and changes, they may use data from various sources to search for patterns of values, culture and perceptions by conducting roadmapping, scenario development, lead user research, or trend analysis to foresee the market of the future [33]. Nevertheless, the insights from these techniques can be too broad, too near future oriented and less applicable for radical innovations [32].

So traditional techniques regarding opportunity recognition can be of limited use for radical innovations. The study of three leading projects indicated use of the Delphi method to gather information about the future possibilities while obtaining the most reliable consensus of each category. According to [34], the Delphi method systematically structures a group communication mechanism to effectively deal with complex puzzles. By doing so, it allows group members to view individual judgment, assess feedback and revise their view while maintaining anonymity for the individual responses.

As opposed to traditional user innovation techniques where research subjects are non-experts and data is analyzed by researchers, the Delphi method is more appropriate here since unbiased group consensus of experts is required.

Selecting hypercritical information by the group of experts themselves without direct confrontation is to ensure the accuracy of the result [29]. First, individual experts are asked to list relevant scenarios of each category. All lists will then be consolidated and duplicates will be removed. The combined list will be sent back to individual experts for further revision and ranking [34]. The study of [28] also confirms that the Delphi method highlights diverse opinions that lead to a set of options for future scenarios.

According to the three cases, relevant scenarios of dishwashing detergent include lifecycle technology where dishwasher waste may provide electrical energy back to the kitchen appliances, self-cleaning, and self-destructed material technology, etc. Regarding the future of mobile content, a few of many scenarios are mobile working, ultra mobile, and healthcare in rural area. While the relevant scenarios of beverage can material include the ability to adjust level of certain chemical compound of liquid inside the can, illustrate live feed information, and alternate between two shapes, etc.

B. Understanding the Market of the Future through Extreme Users

Apart from experts who can provide highly sophisticated future trends, understanding users' unmet needs is crucial. Yet when searching for a successful way of involving users within the innovation process, users' characteristics should be considered [35], [36]. According to [37], if the ideas are to improve existing product performance, gathering input from normal users or typical users is adequate to identify new needs. They are a group of users who use the product in a normal or everyday situation and environment [37]. However, some companies may turn to lead users who are a group of users facing new needs ahead of today's markets and strongly benefiting from innovations that provide solutions to those near future needs [35].

Given the different types of users, [36] proposed user typologies based on the use-diffusion model of [38] and debated that users who possess a certain degree of rate of use and variety of use can influence the ideation process. The study of [39] regarding diffusion of innovation model also reflects the unique characteristics of users based on rate of adoption. They are innovators, early adopters, early majority, late majority and laggards depended upon how fast the users adopt certain products. However, there have been no empirical investigations of whether these groups of users can provide useful input for radical innovation process. Among all users mentioned, none is able to foresee the future as clearly as the most disregarded group of users, extreme users.

Extreme users, in general, are those who reside at the extreme edge of any aspect of research in question: the poorest versus the richest, the tallest versus the smallest, or the oldest versus the youngest, etc. They may represent consumers who live in extreme conditions, at the border of society, excluded from everyday normality, who cannot afford to pay for a certain product or service, or those who choose not to consume it.

There is widespread consensus among scholars and practitioners that extreme users can provide valuable information in identifying new business opportunities.

However, extreme aspects of investigation can vary. For instance, extreme users may refer to those who consider certain features of products very significant to them [37]. Understanding extreme situations may also trigger new insights [40]. In order to find a way to improve a car navigation information system, companies may observe users that include airline pilots and try to understand how they interact and value such a highly sophisticated system in extremely sensitive situations [41], [42]. IDEO, a global innovation consultancy, stated that they learn a lot by understanding users whom they identified as the outliers of a product's bell shape curve in any aspects, such as age, income, product usage, etc. That is where the average customers are at the middle and extreme users are at the left and right extreme of the axis [41]. For example, in order to innovate toothpaste, companies may search for insights from people without teeth or their lack of money to buy toothpaste and study how they find alternatives [43], [44].

Extreme aspects of investigation can vary from extreme needs, extreme environment to extreme usage. Hence, recruiting the right group of extreme users for radical co-creation can be quite a challenge. Companies must be able to distinguish and select only those who are able to provide useful insights. Table I summarizes the different types of extreme users.

According to the three cases, companies could learn from extreme users when searching for social trends or markets of the future. For instance, in the case of future telecommunications, instead of trying to understand typical, mainstream users in the field, more could be learned from a single mother who lives in disadvantageous conditions with three different jobs, taking care of her children and hardly using any mobile services. She certainly may contribute her own ideas as to how mobile telecommunication helps to deal with such challenges in very creative and radical ways. If her child got the flu while she is away at work, real-time transmission of body temperature via mobile application can be useful for a single working mother. There is definitely something to learn from how people live and wish to improve their lives.

Regarding the future of dishwashing detergents and beverage cans, one can try to understand the values and attitudes of those who enjoy take out meals and eat and drink from disposable containers. In other words, those who may have never washed dishes or consumed beverage from a can at all. By learning from those at the extremes, one can engage and think in a non-traditional way when no such product or service may be necessary in the long term future. While extreme users of dishwashing detergent fantasize about having self-cleaning dishware, extreme users of beverage dream of using self-destructed can that does no harm to the environment. This leads to the development of radical innovations to cope with nonexistent needs and alternatives.

The case studies reveal patterns of extreme users who either cannot afford to buy or choose not to consume the products. Additionally, they should be able to provide some forms of alternative scenarios or solution opportunities in dealing with non-usage aspects. In other words, companies should search for those who demonstrate a certain level of use innovativeness or variety of use as mentioned by [38].

However, since some are non-users, use innovativeness characteristics can be captured by investigating their product usage in another category. Non-users, as a result, may expose

hidden traits. In this respect, we name them ‘extreme users of extreme usage’ to differentiate from other extreme users.

TABLE I: THE DIFFERENT TYPES OF EXTREME USERS

Types of extreme users	Examples	Factors
Extreme users of extreme needs	To innovate car's navigation system, airline pilot can be a source of innovation	Needs
Extreme users of extreme usage	To innovate toothpaste, those without teeth can be a source of innovation.	Usage
Extreme users of extreme environment	To innovate for the market at the bottom of pyramid, those who live in disadvantageous environment can be a source of innovation	Environment

The non-usage aspect of extreme users can direct companies to imagine the nonexistent aspects of the long term future because of changing user behaviors and emerging technology. And this is where scenario planning must be employed.

The scenario planning technique helps to develop new ideas that are robust to future uncertainty [45]. According to [46], the technique begins with identification of focal issues or problems. These problems, in turn, will be evaluated to identify key alternatives, which will be further developed into meaningful social and market trends.

A. Analyzing the Matches: Scenarios of Radical Innovation

After gathering information about future technological and social changes from both experts and extreme users, the team together with senior employees from different departments, as diverse as possible, will join in a workshop and try to come up with as many scenarios as possible based on trend information assumptions. These can be new opportunities, impact on existing products, risks, possibility of destroying existing operations, etc.

For the case of mobile service, scenarios may include new opportunities of virtual doctors via mobile application, impact of ultra mobile and longer lifespan. One of many new opportunities of beverage can is the development of sophisticated materials as a result of green movement and mass customization. Regarding dishwashing detergent, new opportunities involve self-cleaning and self-destructed material technology that may destroy existing business operations.

To generate scenarios or alternatives, roleplaying technique can be employed whereby different people are asked to assume the different designated roles and situations and their interactions will be closely observed [47]. This method is best employed to predict diverse outcomes among group interaction. It is especially beneficial when group members are in dispute that involves conflicts of large variations. As a result, various consequences contradicting past events are anticipated [47].

With the multiple scenarios generated, companies can find ways to systematize and select the best ideas by constructing a matrix of social or market changes and technological trends. One side of the axis represents social or market trends of tomorrow’s customers while another side of the matrix reveals emerging technological developments. The

intersection of each cell represents new radical business opportunities or innovation fields. From the unification of social and technological trends, disruptive innovations of the future are derived. It is now up to an interdisciplinary team to decide which intersections reflect the most valuable and feasible radical innovations worth pursuing.

From the three case studies, the most promising intersections are explained, as follows. The brief examples from the three cases are also illustrated in Table II:

- 1) Telecommunication industry: healthcare and education in rural areas will be extremely important. The development of mobile medical toolkits or a real time diagnostic transmitter to doctors with prompt feedback and prescriptions can be anticipated in the next ten years.
- 2) Consumer product industry: lifecycle innovation will be highly important. Cradle to cradle approach will be employed with the use of 100% recycled materials. No waste of byproducts can be expected since the dishwasher of the next generation may be 100% organic and full of live bacteria destroying germs. Energy from such activities will be transmitted back to all kitchen appliances.
- 3) Packaging industry: technological trend is the development of state of the art material that can remember its original shape and alternate between 2 stages when forced to adjust the shape. The social trend is towards stressful work life in the future that may make people want to squeeze something to release the pressure. The unification of the two is the radical idea of beanbag cans.

IV. CONCLUSION

This study suggested the radical co-creation process that begins with identifying key aspects or categorizations surrounding the future research in question. This task can be accomplished by a company’s interdisciplinary team. Next, experts from the different categories specified are invited to explore promising future technologies and possible social changes. In this stage, companies or regular customers cannot provide useful insights of tomorrow since they may lack the ability to understand highly technical aspects that limit cognitive understanding of possible radical innovations [48]. Additionally, they may also fall in the trap of conventional wisdom where they are in the deeply embedded area of comfort and hesitate to approach the topics in question

differently [1].

TABLE II: EXAMPLES OF MATRICES FROM THE THREE INDUSTRIES

Telecommunication (mobile service)	Technological trends		
	Real-time transmission	Medical toolkit	Diagnostic application
Social trends	Work on the go	Mobile medical toolkits or a real time diagnostic transmitter to doctors with prompt feedback and prescriptions	
	Healthcare in rural area		
Ultra mobile			
Consumer product (dishwashing detergent)	Technological trends		
	Self-cleaning material	Self-destructed material	Lifecycle technology
Social trends	Mobile lifestyle	Self-cleaning dishware	
	Environmental concern		
	Energy saving	Self-destructed dishware	Energy generated dishwashing
Packaging (beverage can)	Technological trends		
	Adjustment of chemical compound	Alternate between two shapes	Live feed information
Social trends	Personalization	Sugar level by command	
	Life on the go		
	Stressful worklife	Beanbag can	Sport news on can

Note: Each intersection of technological and social trends reveals possible future scenarios of radical innovations within specified industries.

The next step is learning about the future market through unique perspectives of extreme users, particularly with extreme usage in order to detect currently non-existent possibilities of the focused study. Finally, different scenarios of the unification of technological, social and market trends will be analyzed and recognized by the company's cross-functional team that has knowledge of all aspects of business operations. Their multidimensional analysis certainly can retain the best ideas, screen out impractical developments and generate even more radical insights [1].

Obviously, identifying groups of persons who can provide the most useful information is essential to co-create radical innovations. Moreover, the right data gathering techniques must also be employed to draw beneficial insights for further analysis. With these key drivers, the proposed radical co-creation process can, therefore, facilitate the front-end of innovation and truly empower open innovation into radical opportunity recognition for the next era.

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