Trending Approaches in Innovation Using Interdisciplinary Methods

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ABSTRACT

This presentation presents a study of approaches to foster open innovation, including the use of crowds and social media to leverage and utilize interdisciplinary sources. Crowds are inherently interdisciplinary, and they contain experts. Wisdom can be extracted from these sources. However, the peril of bias and "group think" could be detrimental if not carefully exposed. The process of innovation benefits from a diversity of skills and perspectives. There are technology and communication trends that enable unprecedented access to information, people and even group sentiment, offering new ways to collaborate, connect producers to consumers to investors, and ultimately to innovate. As an example, we will highlight the potential value of applying crowd-sourcing models to commercial and government environments

Keywords: Innovation, Social Computing, Crowdsourcing, Crowdfunding, Gamification

1. INTRODUCTION

We present a study of approaches to foster open innovation, including the use of crowds and social media for continuous innovation. Emerging trends and technologies that will have an impact on open innovation are introduced, as well as an examination of a brief evolution of innovation to understand attributes and patterns for its success and/or failure. We highlight specific examples of their use in "real world" environments and provides an assessment of applicability and challenges for implementation in large organizations.

With the emergence of social computing, an explosion of open innovation can be seen through the combination of gamification with crowdsourcing [6]. Crowds are inherently interdisciplinary, and they often contain experts, each with knowledge that can be leveraged. The process of innovation benefits from a diversity of skills and perspectives that a crowd can offer. Crowds are readily available, and in many cases offer expertise at little or no cost. There are also technology and communication trends that enable unprecedented access to information, people and even group sentiment, offering new ways to collaborate, connect producers to consumers to investors, and ultimately to innovators. Within this combination, innovative applications use emergent game play rather that scripted play. Emergent games define the rules of play but not the outcome, allowing "players" to discover or invent solutions. Prediction markets are used to help scope solutions. We examine a number of recent examples that offer promising results, and can be considered as reference implementations for new business and/or acquisition models.

2. BACKGROUND

There are many sources in literature to study innovation and approaches that attempt to spark or recreate it on a continuous basis for success in business. Simply stated, innovation is about making a significant positive change [1]. Although Innovation stems from many sources, there are essentially six general patterns into which these sources tend to fall:

- *Hard work in a specific direction*: innovations come from dedicated people in a field working hard to solve a problem.
- *Hard work with direction change*: similar to above, but an unexpected opportunity emerges midway through the work.
- *Curiosity*: bright minds following their personal interests.
- *Wealth*: many innovations are driven by the quest for treasure.
- *Necessity*: driven by individuals in need of something they could not find otherwise.
- *Combination*: many innovations stem from any combination of the above.

There are also several challenges to innovation, related to idea generation and solution development, sponsorships

and funding, scalability, customer outreach, competition and timeliness.

Understanding these patterns and challenges will help organizations to better prepare for considering new approaches to open innovation, and promoting a culture of awareness for creativity.

3. EMERGING TRENDS AND TECHNOLOGIES

New forces that are not easily controlled by information technology (IT) are pushing themselves to the forefront of IT spending [16]. Specifically, the forces of cloud computing, social media/networking, mobility, unified communications (UC), convergence and bring your own device (BYOD), and information management are all evolving at a rapid pace [10]. This evolution is largely happening despite the controls that IT normally places on the use of technologies [3]. The cloud offers new delivery styles and options that are industrialized in a value chain in which IT is only one part of that delivery. Social computing allows collaboration and a shift of behavioral patterns of users and the communities in which they work. Mobility offers new access channeled to applications and data and, at the same time, provides end users with a wide variety of choices of devices. UC is not necessarily a single tool, but a set of products that provides a consistent and unified user interface and user experience across multiple devices and media types, thereby enhancing collaboration opportunities. Finally, the concept of big data begins to forever alter the relationship of technology to information consumption. This can be seen as data, now coming from multiple federated sources and in both structured and unstructured forms, which must now be analyzed using new methodologies foreign to many IT departments. As Professor Jeff DeGraff of Michigan's Ross School of Business, and the executive director of the Innovatrium Institute for Technology once said, "Innovation has moved from an individual, organizational sport to a federation sport [10]."

It is important to understand the impact of this nexus of forces on the innovation process. These trends offer unprecedented access to information and people, offering new ways to tap into interdisciplinary resources, collaborate, connect producers to consumers to investors, and ultimately to innovate.

4. APPROACHES TO INNOVATION

Approaches to innovation and its evolution throughout time has been studied and discussed throughout literature [26]. In his discussion of Innovation Models, Tidd discusses the five generations of

- *Linear*: need pull by existing markets and technology/process push, being the first two generations
- *Coupling*: producer/consumer interaction with cooperative feedback
- *Parallel*: supply chain linkages and consumer alliances
- *Network*: integration of systems and markets

Each of these models seeks to address the "sources of discontinuity" that is both the source and result of innovation. These include introduction of new technologies, creation of tipping points in public opinion and social attitudes, shifts in policy and regulation, emergence of new business models, and disruption resulting from unpredictable events. Each of these also may fail to address adequately these sources, the result being that innovation is thwarted or established organizations are blindsided. For example, in the Network model, parochial influences such as culture, education, economics and policy can limit the potential for innovation.

In this presentation, we focus on new and/or emerging techniques, a potential sixth generation, that start to provide an example of evolution toward more open and continuous innovation. Some of these are highlighted below.
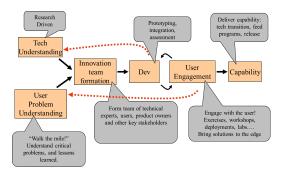

Figure 1. Agile Innovation Cycle with User Engagement

Agile Engineering Innovation Teams: Agile engineering attempts to spark innovation in the development of products or services [4]. The core principles of agile engineering present the notion of smaller time-boxed events, and the use of teams that contained diverse skills and represent all stakeholders associated with the problem at hand. As shown in Figure 1, this process relies heavily on a continuous agile cycle of plan-develop-feedback based on incremental prototyping and delivery [14]. The diversity of the innovation team is key to this approach,

and often as a result, new ideas emerge from the users as they become engaged throughout this cycle.

Open Experimentation Events: Another approach that is becoming more popular with Government customers is to promote innovation with frequent and continuous engagement with users/customers of the product being developed. Some key variants of this approach include:

- *User-driven Field Experimentation*: Realistic Field exercises and test events that allow developers to have users operate and evaluate potential products.
- *User workshops*: Lighter-weight exploratory events that are "realistic enough" to set the proper context for developers and users to evaluate new research opportunities.
- *Multi-party engineering user engagements*: A formal evaluation and product acceptance event performed in conjunction with agile engineering processes.
- *Developer Environments and Testbeds*: Open integration and test environments that identify established standards and interfaces, and provide a common infrastructure to allow 3rd party developers to perform pre-integration of new capabilities.
- *Storyboarding and "Rock Drill" Brainstorming*: Open sessions between users, developers and project leaders using storyboarding and other brainstorming techniques to help define concepts and requirements.

Open Marketplaces: An outgrowth of the developer's testbed, the open marketplace provides a more comprehensive environment for developers to build capabilities in accordance with standards and platform requirements, and make them available through the marketplace for consumers to obtain and use. The "appstores" for mobile applications and desktop widgets are good examples.

In our experience, we have seen these techniques applied in a variety of large government projects with promising results. As a result, Government acquisition policies and processes are changing as open and continuous innovation and agile acquisition becomes the norm. With the increasing popularity and pervasive use of social computing, new approaches for innovation will continue to evolve and shape new ways of conducting business.

5. SOCIAL MEDIA AND CROWDS FOR CONTINUOUS INNOVATION

Social media is a means to an end, not the end itself. Social media enables mass collaboration, in which large and diverse groups of people who may have no preexisting connections pursue a mutual purpose that creates value [2]. Such a group is known as a collaborative community. It is through communities built around mass collaboration that allows an organization or project to enlist the interests, knowledge, talent and experience of everyone along its value chain, to create results that exceed those possible using traditional processes and small-group collaboration techniques.

In order for mass collaboration to be an effective tool, there are three key components that need to be effectively used together:

- *Social Media*: social media is an online environment created for the purpose of mass collaboration.
- *Community*: Communities are collections of individuals who come together to pursue a common purpose.
- *Purpose*: Purpose is what draws people together into a community.

Effectively, community is the people who collaborate, social media is how they communicate, and the purpose is why they communicate. At its heart, continuous innovation is about transforming ideas into products. As customers interact with those products, they generate feedback and data. The feedback is both qualitative (such as what they like and don't like) and quantitative (such as how many people use it and find it valuable). The products can be considered experiments; where the knowledge gained by the organization through these experiments is used to promote, influence and reshape future successful innovations and business models.
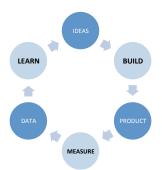

Figure 2. Build-Measure-Learn Loop

This innovation model can be simply visualized as a three-step process, depicted in Figure 2 [17]. The goal is to minimize the total time it takes to traverse this process.

Using this model, successful innovation teams must be structured correctly in order to succeed. Venture-backed and bootstrapped startups naturally have some of these structural attributes as a consequence of being small and independent. For this to work in most organizations, however requires support from senior management to create the appropriate structures, based on several key attributes: scarce but secure resources, independent authority and autonomy to develop business opportunities, and a personal stake in the outcome.

It is also important to establish a platform for open experimentation. This platform should establish ground rules under which autonomous innovators can operate; how to protect the parent organization, how to hold entrepreneurial managers accountable, and how to reintegrate innovation back into the parent organization if it is successful. This *sandbox* for innovation should follow some key principles:

- Any team can create a true split-test experiment that affects only the sandboxed parts of a product or service.
- One team must see the whole experiment through from beginning to end.
- No experiment can run longer that a specified amount of time.
- No experiment can affect more than a specified number of customers.
- Every experiment has to be evaluated on the basis of a single standard of actionable metrics.
- Every team that works inside the sandbox and every product built must use the same metrics to evaluate success.
- Any team that creates an experiment must monitor the metrics and customer reactions while the experiment is in progress and abort or adapt as necessary.

Both developers and customers would work together in partnership in the sandbox, implementing the *build-measure-learn* loop through small iterations. Doing this continuously helps to cultivate an innovative culture throughout the organization and its partners.

The sandbox also needs to evolve into "ideagoras" or marketplaces for ideas, innovations, and for creative people to contribute [19]. This creates the crowdsourcing model that taps into millions of creative innovators, matching them to investors and customers. This allows organizations to "crowd-source" ideas – outsourcing difficult or lengthy tasks to the crowd, which can complete them more efficiently and cheaply than an in-house solution. "Crowd sourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call [11]."

There are several ways to help define the crowdsourcing model beginning with crowd funding. This is the practice of on line "micro-lending" where entities can contribute small sums of money toward a common goal. Next is crowd wisdom. This can be thought of as on-line brainstorming events. Crowd creation is the third component. This can be seen in the open source development environment, where a problem is broken down into small manageable pieces, and the community utilizes spare cycles to solve the problem. Finally crowd voting is the idea of using the opinions of the masses to help define a particular course of action. Google takes this approach with their deployment of "Search" and the way their results are ranked [18].

Another dimension impacting innovation is the realization that creative people (aka. "Right brainers") need to be part of this continuous innovation. With the impact of an abundance of products, outsourcing of logical production of products to Asia, and the automation of redundant processes, it is becoming more important for businesses to find a competitive edge in order to innovate. Creativity is the key to gaining that edge [15]. For that reason, there is an ongoing movement to integrate the Arts and Design disciplines with STEM, thus promoting "STEAM" across Academia and Industry.

There are many examples of approaches based on social media, crowdsourcing and gamification that are starting to emerge. Some of these are highlighted below.
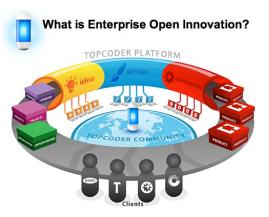

Figure 3. Topcoder Model

Topcoder: The "Topcoder" model, depicted in Figure 3 is based on users and/or investors publishing a need, challenge or problem that has to be addressed, and use crowdsourcing along with games/challenges to motivate creative and talented people to identify innovative solutions [21].

Kickstarter: The "Kickstarter" model is based on allowing individuals or groups with an innovative or creative idea to post that idea as a project by creating a business/project plan, and use crowdsourcing to motivate investors (or anyone) to fund a project [9].

The major funding platform at the moment is Kickstarter [13]. Since it launched in April 2009, over 2.5 million people have used it to pledge over $389 million in funding for more than 74,000 creative projects. Of that, $333 million has gone to projects that met their targets and were ultimately successful.

Kickstarter is an all-or-nothing, no equity funding site. Innovators set a target for funding - be that $10 or $10,000,000 - and have to raise at least that much, or get nothing. The 'no equity' clause means that those who pledge money via Kickstarter do not get any share of the company. If the project fails, funders get nothing. If it succeeds, funders received the benefits originally specified by the project creator. This is done by setting up funding tiers of $1, $5, $10 and so on. Once a donor passes a tier, he or she gets the benefits associated with that tier. What Kickstarter doesn't allow is for users to get either a profit, or a share of the project they're funding.

Industry Collaboration Portals: This approach uses web-based collaboration platforms to create an environment for matching users to subject matter experts for the purpose of answering questions, brainstorming on challenging problems and sharing information about a topic of interest. The MITRE Industry Portals on Cloud Computing and Cyber Security are good examples [22].
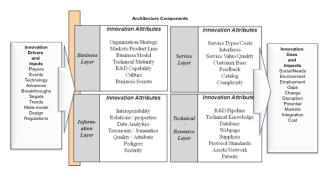

Figure 4. Government use of competitions

Competitions and games to advance research or acquisition: An effective way to motivate crowds of innovators is to provide a challenging game or competition to achieve results. Similar to use of challenges in the Topcoder example, competitions themselves are an effective technique for maturing state-of-art research or for doing down-selects in an acquisition process. Figure 4 illustrates the Defense Advanced Research Projects Agency (DARPA) Grand Challenge, an experimental robotics competition used to further research

in autonomous vehicles [7]. It also illustrates the Robotics Rodeo, a competition used by the United States Government Department of Defense to evaluate robotics solutions as a down-select process for awarding new contracts to vendors [12].

6. COMPLEXITY AND ARCHITECTURE

The forces of cloud computing, social media/networking, mobility and information management resulting in innovation that we see in the crowdsourcing model is typically being impressed upon systems that exhibit high levels of complexity. Complex systems are all evolving at a rapid pace. The cloud offers new delivery styles and options that are industrialized in a value chain in which IT is only one part of that delivery. Social computing allows collaboration and a shift of behavioral patterns of users and the communities in which they work. Mobility offers new access channeled to applications and data and, at the same time, provides end users with a wide variety of choices of devices. Finally, those characterized as having unpredictable behavior, fluid requirements, multiple competing stakeholders, and are susceptible to external pressures that can cause change across the entire system [20]. Complex Systems are constantly changing. They respond and interact with their environments – each causing impact on (and inspiring change in) the other, usually through bottoms-up disruption, not top-down orchestration.

New architectural paradigms are needed to expose opportunities for as well as the results of innovation via crowdsourcing approaches. The normal views are Operational (Business), Service, Information, and Technical. But these views do not address Innovation. In Figure 6 we provide a notional Architectural representation of generating an Innovation View via capturing and describing a set of innovation attributes.

Figure 5. Notional Innovation View

An Innovation view would highlight those areas of the architecture that support (or are ripe for) innovation. The

innovation view would also highlight how the architecture supports evolutionary aspects of the design.

7. CONCLUSIONS

Although emerging technologies and trends may be creating an environment conducive to innovation, there are several issues which can be seen as barriers to innovation becoming prevalent in today's society. First, is the need for more and better talent. Recent test scores and the number of graduates in science, technology engineering and mathematics (STEM), is not encouraging. [5] The students of today may not be prepared to be the innovators of tomorrow. Secondly, the availability of active research and development (R&D) programs in organizations can impede overall innovation. Finally, tied to the R&D "shortfall" is the actual availability of capital to fund innovation programs. As the US and many other countries cope with recession or other financial difficulties, innovation funding tends to be a lower priority [8]. For these reasons, it is even more important for organizations to look for creative and cost-effective ways to innovate.

We have presented a study of several approaches to foster open innovation, including the use of crowds and social media for continuous innovation. It provides an assessment of applicability and challenges for implementation in large organizations. We have identified the most common barriers to true innovation as well as emerging technologies and trends which, we believe will fuel the spark of innovation in the near future. These technological trends, taken together, offer unprecedented access to information, people and even group sentiment, offering new ways to collaborate, connect producers to consumers to investors, and ultimately to innovate. We investigated the crowd-sourcing model and its potential value applied to commercial and government environments.

8. REFERENCES

[1] Berkun, S., *The Myths of Innovation*, O'Reilly Media, Inc., 2010.

[2] Bradley A. and M. McDonald, *The Social Organization*, Gartner, Inc., 2011.

[3] Cappuccio, D., *Ten Critical Trends and Technologies Impacting IT During the Next Five Years*, Gartner Symposium/ITxpo presentation, 21-25 October 2012.

[4] Cherinka, R. and R. Miller, *Agile Engineering of Scalable Enterprise-Level Capabilities*, World Multiconference on Systematics, Cybernetics and Informatics, 2008.

[5] Cherinka, P. Wahnish, J. Prezzama, *Fostering Partnerships between Industry and Academia to Promote STEM at the Secondary Educational Level, EEET Plenary Presentation, July 2012.*

[6] Cohen, L., *To the Point: Leverage the Power of the Collective Without Getting Lost in the Crowd*, Gartner Symposium/ITxpo presentation, 21-25 October 2012.

[7] DARPA, http://www.darpagrandchallenge.com/

[8] Davidson, John, Keystone Edge, , May 07, 2009, http://www.keystoneedge.com/features/jeffdegraff0507.aspx,

[9] Griliopoulos, D., *The Madness of Crowdfunding*, Maximum PC Magazine, pp 45-51, March 2013.

[10] Howard, C., *The Nexus of Forces Scenario*, Gartner Symposium/ITxpo presentation, 21-25 October 2012.

[11] Howe, Jeff, Crowdsourcing, *Why the Power of the Crowd is driving the Future*, http://www.crowdsourcing.com/.

[12] JIEDDO Robotics Rodeo Challenge, 2012, http://www.army.mil/article/83762/Robotics_Rodeo_highlights_advances_in_life_saving_technologies/

[13] www.kickstarter.com

[14] MITRE Technical Presentation, Warfighter Integration Technology Strategy, The MITRE Corporation, 2006.

[15] Pink, D., *A Whole New Mind*, Riverhead Books, Penguin Group Inc., 2006.

[16] Plummer, D., *Top Technology Predictions for 2013 and Beyond: Control Slips Away*, Gartner Symposium/ITxpo presentation, 21-25 October 2012.

[17] Ries, E., *The Lean Startup*, Crown Business, Crown Publishing, 2011.

[18] Sloane, P., *A Guide to Open Innovation and Crowdsourcing: Advice from Leading Experts*, Kogan Page Publishing, 2012

[19] Tapscott, D. and A. Williams, *Wikinomics*, Penguin Group Inc., 2008.

[20] Tidd, J., *Innovation Models*, Discussion Paper, Imperial College London, 2006.

[21] www.topcoder.com

[22] Metzger, Louis, MITRE Cloud Computing Portal, http://www.mitre.org/work/info_tech/cloud_computing/