AIS SIGPRAG

Pre-ICIS Workshop 2016
"Practice-based Design
and Innovation of
Digital Artifacts"

The Digital Innovation Design Activities Wheel

Shirley Gregor[1] and Alan Hevner[2]

[1] Australia National University, Canberra, Australia (shirley.gregor@anu.edu.au)
[2] University of South Florida, Tampa, FL, USA (ahevner@usf.edu)

Abstract

While the importance of innovation as a dominant driver of societal and economic progress is well established, the processes and outcomes of the new phenomena of digital innovation (DI) are diverse. Managers and practitioners should benefit from a sense-making device that helps them better understand the opportunities and practices in the DI landscape. Thus, an original framework named the Digital Innovation Design Activities Wheel is proposed that builds on prior influential work on portfolio approaches to innovation (e.g. the ambidexterous approach) combined with recent thinking that modern strategic management of innovation should be based on innovative design activities. The Wheel framework relates DI design activities to different digital innovation outcomes in cyclic processes. It integrates work on portfolio approaches to innovation, the Knowledge-Innovation Matrix (KIM), theory of creativity, knowledge flows and innovation design activities in the context of DI. The framework is informed by analysis of case studies of DI of different types. We conclude with an agenda for future research to extend DI innovation theorizing and with actionable advice for improving current practices of innovation.

Keywords: Digital innovation, design activities, innovation portfolio, knowledge innovation matrix

1 Digital Innovation

Innovation in technical fields has long been a concern for corporate managers and information technology (IT) professionals. The phenomena of digital innovation (DI) has increased concerns; with new digital technologies, information digitization, digitally-enabled generativity, and a greater range and reach of innovation across organizational boundaries (e.g. see Yoo et al. 2010; Fichman et al. 2014). Surveys show that organizations view DI to be of vital importance (e.g. Morrell 2015).

There is a large range of theory and advice on strategies for traditional innovation, yet the diversity of both opportunities with DI and the means of taking advantage of these opportunities can lead to the "big picture" being lost. For example, a large bank is successfully using a "labs" approach with many innovation techniques such as rapid prototyping and co-design with users with the goal of getting new digital products and services to market in 12 week cycles (Korporaal 2016). At the same time, the bank has to implement new advances in platform technologies to serve as a base for the innovative apps that are developed in short cycles. This development work is considerably more substantial, expensive, longer-term, and relies on the traditional design practices of a professional IT staff. A McKinsey report describes this situation as "two speeds" innovation, with rapid cycle innovations occurring alongside slower more substantial innovation activities (Blumberg et al. 2016). However, no detailed advice is given as to how to bring about this two speed state. Our initial case work has shown that managers in innovation labs can be largely unaware of the longer term innovation strategies at play elsewhere in the organization. A higher order sense-making device would be an advantage.

We see an opportunity to build on prior influential work on portfolio approaches to innovation (e.g. the ambidexterous approach as in O'Reilly and Tushman 2004) combined with recent thinking that the strategic management of innovation should be based on "innovative design activities" (Le Masson et al. 2010).

Thus, the goal of this study is to propose a new framework for Digital Innovation Design Activities (DIDA), termed the DIDA Wheel. This framework relates DIDA to different digital innovation outcomes in cyclic processes. The new framework integrates work on portfolio approaches to innovation, theories of creativity, knowledge flows, the Knowledge-Innovation Matrix (KIM) of Gregor and Hevner (2014), and innovation design activities. The framework is informed by analysis of case studies of innovations of different types.

We explicitly adopt a process-based, cyclic view of innovation, as in Van de Ven et al (2008), as opposed to a linear stage-gate approach. In the older stage gate models, a number of the planning and ideation activities would occur in the early front-end of innovation (FEI) (see Koen et al. 2014a, 2014b). However, experiences with DI show that the older stage gate models are not appropriate. In particular, they do not support very rapid cycle innovations where the stages would not be easily distinguishable (as in the 12 week cycles in the bank's innovation labs).

The focus of this paper is on design activities, as in Le Masson et al. (2010) rather than management of innovation more generally, which includes topics such as entrepreneurship. The latter topics are important but are not our current focus. The work is research-in-progress, although it builds on and extends prior work by the authors on innovation techniques in IT fields. From prior theory we expect that organizations that are successful in DI employ a range of DIDA, appropriate to their place in a digital ecosystem. However, this claim is outside the scope of our research-in-progress.

2 Conceptual Background

The new DIDA framework proposed here integrates theory from portfolio approaches to innovation, theories of creativity and knowledge production, recent thinking on innovation design activities, and digital innovation theorizing. This section provides a brief survey of the foundations for our future research directions.

2.1 Portfolio Approaches and Innovation

Prior work has identified what might be termed "portfolio" approaches to innovation management, in that organizations are encouraged to engage in innovation strategies (activities) of more than one type and some means of classifying innovations is provided. We review a number of these approaches below. Note that we have not included the common radical-incremental categorization, as we regard these categories as referring to outcomes or impact of the innovation, rather than the innovation activity that occurs. In our new framework both radical and incremental innovations could occur across the framework's categories.

Many ways to classify innovations and innovation strategies have been advanced, as noted in reviews by Garcia and Calantone (2002) and Miller and Miller (2012). Some basic dichotomous classifications include the distinction between exploration and exploitation, introduced by March (1991) in relation to learning. March saw exploration as “search, variation, risk taking, experimentation, play, flexibility, discovery, innovation” (p. 71). Exploitation was “refinement, choice, production, efficiency, selection, implementation, execution” (p. 71). Firms that behave ambidextrously, effectively balancing exploration and exploitation are nine times more likely to achieve breakthrough products and processes than others, even while sustaining their existing businesses (O’Reilly and Tushman 2004).

The innovation process overall for DI is expected to correspond with the non-linear models proposed by Van de Ven et al. (2008) on the basis of extensive research. These authors question stage-wise (stage-gate) models that see the innovation process as progressing through a series of stages or phases, such as invention-development-testing-commercialization. Instead, they see a richer process that is more complex and uncertain than stage models. They believe that innovation can be accomplished in a number of different ways and that the innovation journey can unfold along many different paths.

2.2 Innovation Theories

Underlying theories for innovation relevant to our study come from the literature on creativity and knowledge creation. According to Burkus (2014, p. 15), “creativity is the starting point for all innovation” where creativity is defined as “the process of developing ideas that are both novel and useful” (Amabile 1996). Amabile (1983; 2012) posits that four components are necessary for a creative response:

- Domain-relevant skills include intelligence, expertise, knowledge, technical skills, and talent in the particular domain in which the innovator is working;
- Creativity-relevant processes include personality and cognitive characteristics that lend themselves to taking new perspectives on problems, such as independence, risk taking, self-discipline in generating ideas, and a tolerance for ambiguity.
- Intrinsic task motivation is seen as a central tenet. “People are most creative when they feel motivated primarily by the interest, enjoyment, satisfaction and challenge of the work itself – and not by extrinsic motivators.” (p. 3).
- The social environment, the only external component, addresses the working conditions that support creative activity. Negative organizational settings harshly criticize new ideas, emphasize political problems, stress the status quo, impose excessive time pressures, and support low-risk attitudes of top management. While positive organizational settings stimulate creativity with clear and compelling management visions, work teams with diverse skills working collaboratively, freedom to investigate ideas, and mechanisms for developing new ideas and norms of sharing ideas.

It is important to note that Amabile’s work is based on two important assumptions. First, there is a continuum from relatively low, everyday levels of adaptive creativity to the higher levels of creativity found in significant inventions and scientific discoveries. Second, there are degrees of creativity exhibited in the work of any single individual at different points of time and circumstances (Amabile 2012).

The connections among existing knowledge sources and the generation of new ideas are also fundamental to innovation. “Innovation is about knowledge – creating new possibilities through combining new knowledge sets” (Tidd and Bessant 2009 p. 37). At the organizational level the work of Nonaka and colleagues on the “knowledge-creating” company depict the central importance of knowledge for innovation and focus on changes from tacit to explicit knowledge in a spiral process (e.g. Nonaka 1991; Nonaka et al. 2008). Nonaka (1991) shows how innovations are linked to novel ideas, which can be gleaned from individuals’ tacit knowledge. For example, the Matsushita product development company incorporated ideas obtained from careful observation of an expert human bread maker into the design of a superior bread making machine.

2.3 Innovation Design Activities

Further, our work follows the reasoning of Le Masson et al (2010), who argue that:

Firms which try to develop their innovation capabilities must place a new emphasis on design activities. These must be carefully organized and managed, especially in the case of innovation design. Although they play a central role in most industrial firms today, relatively little is documented about these design activities, which leads us to believe that they have not been studied in any great detail. (p. 51).

They argue further that critical properties of design activities include the exploitation and extension of existing knowledge as well as the imagining of new objects of design. These properties fit well with the Knowledge Innovation Matrix (KIM) that we describe in a subsequent section.

Figure 1 shows our perspective on design activities, based on prior work (Gregor and Hevner 2014; 2015). We believe that, overall, the pattern represented by the components of this model taken together, will vary depending on the quadrant in which the innovation is placed in the KIM matrix. However, our focus in this current work is primarily on the devise, design and deliver activities.

Note that as well as design activities, we also distinguish “innovation techniques”, which we see as tools or methods that can be used in DIDA and have to some extent been explicitly formalized and given a name. Many such techniques exist. De Pra Carvalho et al. (2012) list 67 techniques that contribute to idea generation and innovation. Pricewaterhouse Coopers (PWC 2015) show that organisations use multiple tools and techniques for innovation. The results of their survey indicates that most organizations use traditional idea generation techniques such as direct customer observation, traditional market research, feedback from sales and customer support, idea work-out sessions, technology road mapping and other sources. Another example is the “innovation toolkits” proposed by von Hippel (2001) that support collaborative innovation projects between users and producers.

Few prior studies have differentiated practices (activities) by type of innovation. An exception is the study by Koen et al. (2014a) that focuses on front-end innovation and examines activities in terms of the New Concept Development model (NCD) to show that the processes for radical innovations differ from those for incremental innovations.

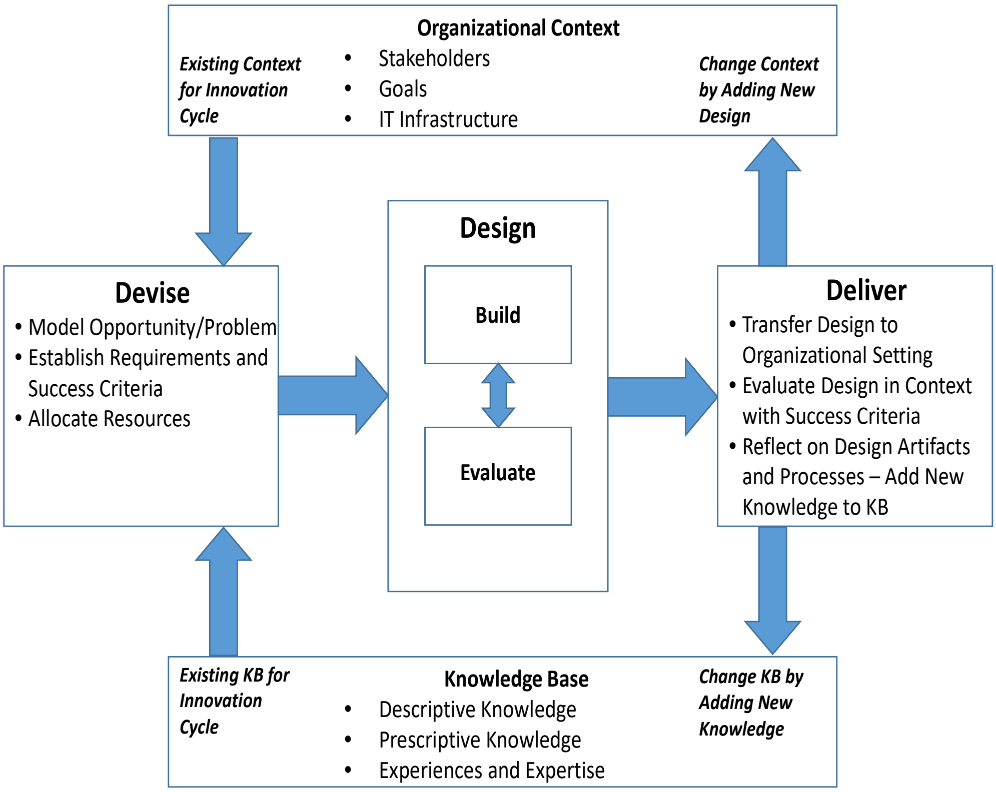

Figure 1: A Pattern of Design Activities in the Innovation Context

2.4 Knowledge-Innovation Matrix (KIM)

As a base for our new DIDA framework, we use the Knowledge Innovation Matrix (KIM) developed by Gregor and Hevner (2014). This 2x2 typology in Figure 2 offers a finer-grained view than simple dichotomous classifications and is firmly based in the fundamental differences in triggers of an innovation - needs-pull (problem trigger) and technology-push (knowledge trigger) (Tidd and Bessant 2009) and the combinations of these two triggers. KIM extends and combines prior work on classifying innovations on two dimensions (e.g. Ansoff 1957; Danneels 2002; Miller and Miller 2012).

The two dimensions that form the basis of the matrix are:

1) The knowledge (solution) maturity dimension, which resonates with the key roles in innovation of new ideas (Van de Ven et al. 2008; Rogers 2003), new insights (Mascitelli 2000), new knowledge and skills (Leonard-Barton 1992), technological know-how (Rothwell and Gardiner 1985), new knowledge (Levinthal and March 1993), and learning (March 1991).
2) The application domain (problem) maturity dimension, which resonates with the key roles in innovation of opportunities (Tidd and Bessant 2009), tasks and problems (Horenstein 2002), markets (Danneels 2004), needs (von Hippel and von Krogh 2013) and fields (Cropley and Cropley 2010).

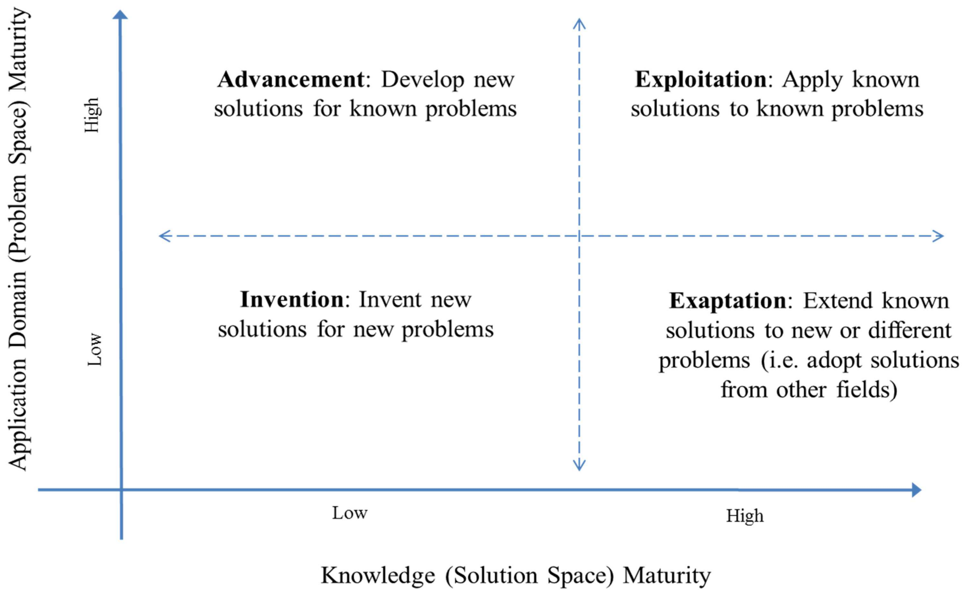

Figure 2: The Knowledge Innovation Matrix (adapted from Gregor and Hevner 2014)

The KIM quadrants are described here briefly and the reader is referred to Gregor and Hevner (2013; 2014) for further detail. Exemplars for each quadrant, some from very well-known cases, are provided.

1) The invention quadrant includes very novel innovations that are seen as "new to the world", where both the idea of the problem or opportunity, and the knowledge to solve it, have not been recognized before. Recognition of the application domain and the related solution knowledge are both low. The development of Post-it notes at 3M (Burkus 2014) is one example and the World Wide Web is another (Berners-Lee and Fischetti 2004). In both cases the inventors were working on personal projects outside their normal work duties and "tinkering".
2) The exaptation quadrant includes innovations where knowledge of how to satisfy one particular need or application function is applied to another need or market in a completely different field. Solution knowledge is well advanced, but recognition of how to apply that solution to the specific application area is low. An example is the laser printer that was exapted from the photo-copier (Reilly 2003).
3) The advancement (improvement) quadrant includes innovations where a better solution is developed for a known problem. The difference between this quadrant and the invention quadrant is that here the goal of the innovation effort can be specified at the outset. Solution knowledge is suboptimal, but recognition of the problem is high. The development of the stealth technologies at Lockheed Martin by a team of specialist engineers in "skunkworks" is an example (Rich and Janos 1996).
4) The exploitation quadrant includes innovations which are seen as "new-to-us" rather than "new-to-the-world." Known solutions are applied to known problems, often with some customization. Innovative work in this quadrant can be seen as

professional design and development and an organization could derive considerable value from the innovation. An early example is the Sabre online reservation system (Hopper 1995).

2.5 Digital Innovation

There is clear agreement that DI is different in type from other more traditional types of innovation (see Fielt and Gregor 2016 for a fuller analysis). Yoo et al. (2010, p. 725) define DI as "the carrying out of new combinations of digital and physical components to produce novel products". These authors see digitization, i.e. the encoding of analogue information into digital format as necessity for DI. Fichman et al. (2014, p. 330) define DI as "a product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT." Further, these authors identify three distinctive characteristics of digital technologies: digitalization, Moore's laws (rapid, often exponential, price-performance improvements) and network effects.

Theorizing with DI reflects on the phenomena of generativity. Yoo et al (2010) see that the characteristics of DI enable layered as opposed to modular architectures. A hybrid, layered modular architecture emerges when digital components are turned into physical products. The loose coupling across the layers of the architecture enables generativity: i.e. "a technology's overall capacity to produce unprompted change driven by large, varied and uncoordinated audiences" (Zittrain, 2006, p. 1980). Moreover, the layered modular architecture will only realize its generative potential when it comes with a new organizing logic of doubly distributed networks where the control over product components as well as the product knowledge is distributed amongst multiple actors.

What does this thinking on DI mean for innovation activities? As yet this question has not been fully explored, which provides the motivation for our work. From the thinking above, we could expect that DI innovation activities will include:

- Using existing technologies (e.g. the Internet, GPS positioning) and applying them for purposes for which they had not been used before to give new digital products and services (exaptation);
- Multiple actors involved in innovation activities in networks, across organizational boundaries, possibly enabled by IT such as in crowd-sourcing;
- A more rapid pace in the development of some DI; and
- Layered architectures (as in platforms) enabling generativity: i.e. the technology itself is a major "actor" in the DI activities.

3 Research Method

Our current status is research-in-progress, although it builds on pilot work on innovation techniques in IT fields (Chadha et al 2015). The base for the framework was developed analytically from KIM (Gregor and Hevner 2014) and theory of digital innovation. Examples of digital innovations were then located for each quadrant and the DIDA that occurred for those innovations were identified. These cases serve as an initial illustration of the framework's applicability. In future work it is proposed to develop the framework with grounding in further case studies and action design research in the field.

4 A Framework for Digital Innovation Design Activities

Figure 3 shows the new framework – the Digital Innovation Design Activities Wheel[1]. This framework aligns with the patterns of design activities in Figure 1, but also uses the KIM matrix (Figure 2) to depict different types of innovation. The purpose of the framework is to provide a sense-making device showing how different innovation activities and techniques can be used for different types of innovation.

Note that the Wheel is not meant to show that all innovations can be neatly classified into one or other of the segments. Some innovations will be borderline, for example between invention and advancement. We might see one innovation traversing more than one segment. For example, the radar stealth technology began as a flash of insight when a scientist connected an obscure math paper with the radar problem he was working on and also realized that new computing power could be brought to bear on the problem. Nevertheless, he did have a problem in front of him and heavy R&D did ensue, so this is classed as advancement. Similarly, some techniques can be used in more than one quadrant. What is shown are some common patterns that are expected from theory and have been observed.

At the innermost level of the Wheel is the knowledge, both descriptive and prescriptive (technology), that serves as a base for innovation. At the next level are the activities and techniques that can be used across all quadrants for creativity, which is seen as needed for all types of innovation. One more step out is the different design activities that can be employed for different innovation types.

The ring with the arrows signifies that there is likely to be movement from one quadrant to another in cyclic processes for one specific innovation. For example, the innovation could arise as “new-to-the world” in the invention quadrant, be refined into another innovation in the advancement quadrant (perhaps with quite a significant improvement, as in the stealth technology at Lockhead Martin), and then be exploited in appropriation activities as a “new-to-us” innovation.

The outermost ring also indicates the organizational environment and the managerial (or designer) choices that need to be made about which innovation types and activities to be engaged in, when and how exactly. Activities in more than one quadrant can be engaged in at one time, and from ambidexterity theory we expect that this would be desirable.

Each of the different quadrants for design activities is now explained in further detail.

[1] Unbeknownst to the authors before naming the framework, a “Plot Wheel” already exists that has been used by authors of detective novels to generate plot lines. This is an example of unconscious exaptation. The Plot Wheel, as with the DDIA Wheel, can be used to choose more than one story thread running in parallel. URL: http://blog.karenwoodward.org/2013/10/nanowrimo-erle-stanley-gardner-perry-mason-plot-wheels.html

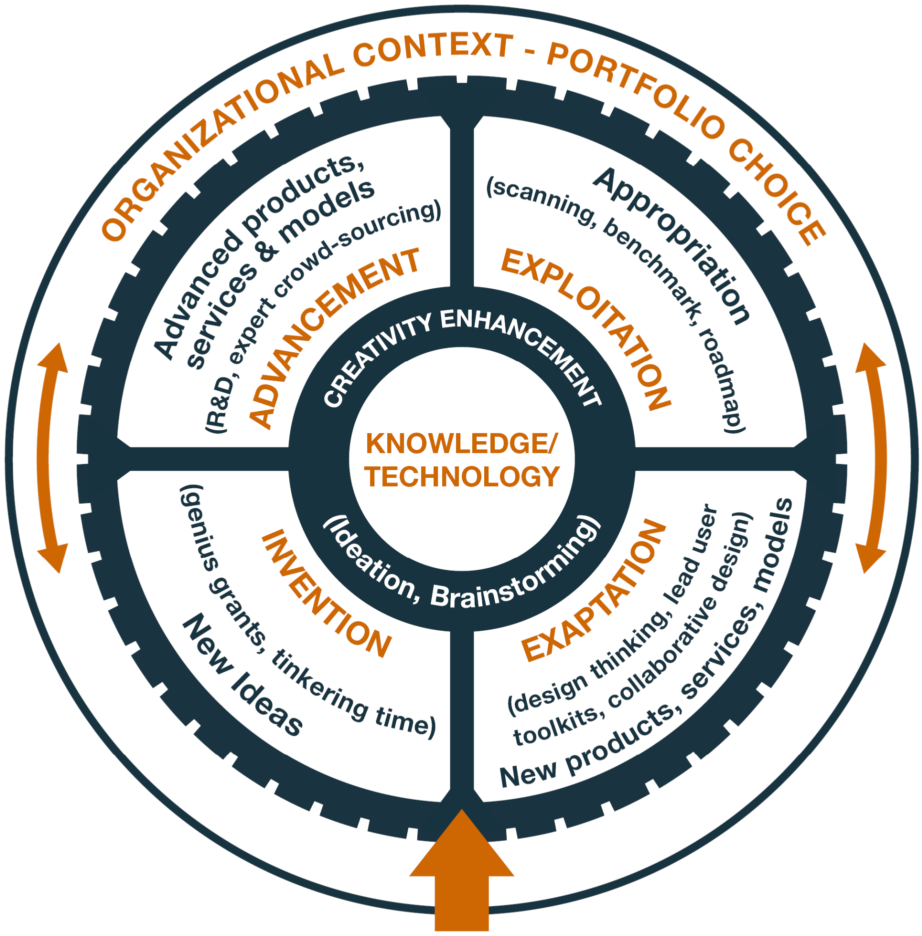

Figure 3: The Digital Innovation Design Activities Wheel

1) Invention Quadrant

The invention quadrant is the one in which both existing domain knowledge and application knowledge are low, thus high levels of creativity are required to generate novel ideas and the use of conditions fostering creativity are important. Radical, out-of-the-box thinking is valued and non-conventional approaches for the development of ideas will be employed. Organization policies that foster creativity are key, particularly those that allow employees time to think and try out their own ideas.

Specific techniques for DIDA that could be used in this quadrant include genius grants and bootlegging. Genius grants allow time granted to employees to work on individual innovation projects apart from their normal routine work. A similar practice is bootlegging, although this is a clandestine bottom-up activity hidden from the top management of the organisations (Criscuolo et al. 2014; Masoudnia and Szwejczewski 2012). Other examples are the "tinkering time" at 3M and "hack-a-thons".

With the World Wide Web, Berners-Lee feared that a superior might put a stop to his "universal hypertext system", as it had little relationship with particle-physics research on which he was supposed to be working. For four years, Berners-Lee kept introducing the Web as a way to help CERN to manage its internal information to attract funding. He called this period the "phase of persuasion". However, the program went through a tough time, as it was not officially sponsored by CERN. A manager referred to it as "vague but interesting".

2) Exaptation Quadrant

In the exaptation quadrant a novel association is found between existing solution knowledge in one field and a challenging opportunity in another field. As in the invention quadrant, a relatively high level of creativity and associative thinking are required to generate the novel relationships between the existing knowledge and a new application. The important thing here is to conceptualize an association between the existing technology and some purpose that is different from what was originally envisaged. We want to find new niches for existing technologies in which connections are made between apparently disparate ideas, either from very creative individuals or a group with diverse ideas.

Specific techniques for DIDA that could be used in this quadrant include crowd-sourcing (non expert), design thinking and collaborative design activities that allow connections between a technology (knowledge) and a new use for the technology.

Many of the new business models formed by applying digital technologies to give new products and services fall into this category: e.g Facebook and Uber. Internet and mobile technologies are used for purposes other than those for which they were originally developed.

The NAB labs innovation center provides many other examples. For example, they developed an app for fans at games stadium to allow them to order food from their seats. The app is "one of a new range of products coming out of NAB Labs, an ideas incubation arm of the bank set up some 18 months ago to look for more creative ways to design new products" (Korporaal 2016).

3) Advancement Quadrant

The advancement quadrant is the one in which there is less than optimal solution knowledge for achieving a relatively well-understood application. The goal is to achieve a significant advance on existing knowledge for solving a particular problem. People are needed who are experts with deep relevant domain knowledge. However, with DI, these experts may lie outside the organization.

Methods in this quadrant include typical research and development (R&D) activities, such as that described for design science research with IT (Peffers et al. 2008). Gregor and Hevner (2013) show in an analysis of 13 design science articles in a leading journal that the majority (77%) fell into the improvement (i.e. advancement) quadrant.

Today, it appears that companies may often prefer to "buy in" R&D projects with promise rather than depending on innovation activities within organizational walls. Many examples could be provided but one example is Google Maps, which was an advancement on an earlier form of computerized mapping tool, MapQuest.

Instead of online mapping leader MapQuest's printable list of directions, navigation routes were overlaid on top of the map itself. And Google Maps loaded map tiles in a Web browser without any special software so you could explore the world without refreshing, a technical feat that had never been seen before. (Gannes 2015).

Note that GoogleMaps was originally developed at a mapping technology company *Where 2 Technologies*, but was then acquired by Google and became Google Maps. The results of R&D activities were bought in from outside the company (Gannes 2015).

4) Exploitation Quadrant

The exploitation quadrant is the one in which there is mature domain knowledge for achieving a well-understood application or function. The goal is then to optimize the functioning of a state-of-the-art technology in a new application environment. The innovation is new-to-me or new-to-us rather than new-to-the-world

Specific techniques for DIDA that could be used in this quadrant include benchmarking and managerial scanning (as in Rogers 2003). Benchmarking involves measuring and comparing the organisation's operations, practices and performance against other organisations. It is a market-based management tool by which the firms identify the best practices that have produced superior results in other firms and replicate these practices to improve its own competitive advantage. (Copp 2002; Sekhar 2010; Vorhies and Morgan 2005).

A successful example of benchmarking is the Chinese e-commerce giant Alibaba creating Taobao as a defensive move against the US rival eBay who started operations in China. According to Greeven et al. (2012), Taobao bested eBay in China and now holds 80% of China's e-commerce market. Taobao benchmarked the concept of online auctions from eBay and made customisations to EBay's practices to suit Chinese customers.

Many platform innovations could be included here. Ideas for platforms are not new but a company may spend large amounts of effort in developing one because of the foundation it provides for subsequent innovations. The NAB bank, amongst others, has spent money investing in Block Chain technology.

5 Discussion and Conclusions

This research adds to theory of management strategies and portfolio planning for innovation by presenting a new framework for a DI portfolio of design activities. Use of the design activities Wheel framework for DIDA can help raise organizational awareness of a range of activities that can be pursued in achieving DI outcomes. The theory behind the framework also shows why some activities and techniques are better suited to one type of innovation rather than another.

At this point our focus is on design activities, rather than the broader organizational context in which the activities occur. Our framework shows that, although some design activities such as ideation occur across quadrants, some activities are more likely to be associated with one quadrant in the KIM matric than others. We advance conjectures in this respect:

- Innovations in the invention quadrant will be associated with creative processes within an individual or group that are facilitated by conditions such as free time for thinking, tinkering and experimenting, outside normal duties.
- Innovations in the exaptation quadrant will be associated with design activities that allow the identification of new user needs that can be met by an existing technology, such as collaborative design and design thinking that involve end users as well as designers. These activities may occur in relatively short cycles.

- Innovations in the advancement quadrant require individuals with some degree of expertise related to the problem area and traditional R&D-type activities are likely to be used.
- Innovations in the exploitation quadrant require recognition that existing technologies could be adopted or appropriated with some re-design by an organization or individual. Scanning and benchmarking activities are useful.

The research has theoretical significance as it adds to the sparse literature on design activities with DI. It is itself in part design science work as it proposes a tool, theoretically based, that can be used in practice to assist managers and designers in their choices regarding DI design activities. Such a tool is needed as it is common for methods and techniques for design activity to be proposed without any advice as to which type of innovations they best suit. One of the authors is a Director of an Innovation Hub that is already using the Design Activities Wheel to help guide the services that are offered by the Hub in terms of DI design techniques. On-going research will explore the best practices of employing the DIDA Wheel to build world-class DI portfolios.

Further research will also be performed utilizing case studies in the field to enrich the framework. In addition, we will test the supposition that the framework will be useful to managers and innovators in action design research and investigate to what degree successful organizations use a range of DIDA across the Wheel.

Acknowledgements

We gratefully acknowledge funding from the Schoeller Research Center at the Friedrich Alexander University Erlangen-Nuremburg, Germany for these research efforts.

References

Amabile, T. 1983. “The Social Psychology of Creativity: A Componential Conceptualization,” *Journal of Personality and Social Psychology*, 45, 2.

Amabile, T. 1996. *Creativity in Context: Update to the Social Psychology of Creativity*. Boulder, CO: Westview.

Amabile, T. 2012. Componential Theory of Creativity, Working Paper, Harvard Business School, April. URL: www.hbs.edu/faculty/Publication%20Files/12-096.pdf (Accessed 10 March, 2014)

Ansoff, I. 1957. “Strategies for Diversification,” *Harvard Business Review* (35:5), pp. 113-124.

Berners-Lee, T and Fischetti, M. 2004. *Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web by Its Inventor,* Demco Media.

Blumberg, S., Bossert, O., and Laartz, J. 2016. Deploying a two-speed architecture at scale. *McKinsey&Company*. Available at: file://cbe-users/users/u5102708/Downloads/Deploying-a-two-speed-architecture-at-scale.pdf

Burkus, D. 2014. *The Myths of Creativity*. Jossey-Bass.

Chadha, Y., Mehra, A., Gregor, S. and Richardson, A. 2015. “A Framework for Techniques for Information Technology Enabled Innovation,” Australasian Conference on Information Systems, Dec, Adelaide.

Copp, N.A. 2002. “Benchmarking in ambulatory surgery,” Association of Operating Room Nurses Journal (76:4), pp. 643-647.

Criscuolo, P., Salter, A. and Wal, A.L.J.T. 2014. "Going Underground: Bootlegging and Individual Innovative Performance," *Organization Science* (25:5), pp. 1287-1305.

Cropley, D. and Cropley, A. 2010. Functional Creativity "Products" and the Generation of Effective Novelty, In *The Cambridge Handbook of Creativity*, J. Kaufman and R. Sternberg (eds.) Cambridge: Cambridge University Press, pp. 301-317.

Danneels, E. 2002. "The Dynamics of Product Innovation and Firm Competencies," *Strategic Management Journal* (23:12), pp. 1095-1121.

Danneels, E. 2004. "Disruptive Technology Reconsidered: A Critique and Research Agenda," *Journal of Product Innovation Management* (21:4), pp. 246-258.

De Pra Carvalho, A., de Matos, E. A., dos Reis, D. R., Serpe, L. F., and Carvalho, S. 2012. "Tools for Creativity," *US-China Education Review* (2:11), pp. 936-946.

Fielt, E. and Gregor, S. 2016. "What's New about Digital Innovation?". Information Systems Foundation Workshop, Canberra, Australia, Sept.

Fichman, R. G., Dos Santos, B. L., and Zheng, Z. 2014. "Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum," *MIS Quarterly* (38:2), pp. 329-343.

Gannes, L. 2015. Ten Years of Google Map, From Salshdot to Ground Truth. *Recode.* Available at: http://www.recode.net/2015/2/8/11558788/ten-years-of-google-maps-from-slashdot-to-ground-truth

Garcia, R. and Calantone, R. 2002. "A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review," *The Journal of Product Innovation Management* (19:2), pp. 110-132.

Greeven, M., Yang, S., Yue, T., Heck, E. and Krug, B. 2012. "How Taobao bested Ebay in China," *Financial Times*. Available at: http://www.ft.com/intl/cms/s/0/52670084-6c2c-11e1-b00f-00144feab49a.html#axzz3YvVpoq9

Gregor, S. and Hevner, A. 2013. "Positioning and Presenting Design Science Research for Maximum Impact", *MIS Quarterly*, 37, 2, 337-355.

Gregor, S., and Hevner, A. R. 2014. "The Knowledge Innovation Matrix (KIM): a clarifying lens for innovation," *Informing Science: The International Journal of an Emerging Transdiscipline* (17), pp. 217-239.

Gregor, S. and Hevner, A. 2015. "The Front End of Innovation: Perspectives on Creativity, Knowledge and Design," *DESRIST 2015*, May, Dublin, Ireland.

Horenstein, M. 2002. *Design Concepts for Engineers*. (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.

Koen, P., Bertels, H., and Kleinschmidt, E. 2014a. "Managing the Front End of Innovation – Part I," *Research-Technology Management* (57:2), pp. 34-43.

Koen, P., Bertels, H., and Kleinschmidt, E. 2014b. "Managing the Front End of Innovation – Part II," *Research-Technology Management* (57:3), pp. 25-35.

Korporaal, G. 2016. NAB Labs prepare bank for the future. The Australian Business Review, Available at: http://www.theaustralian.com.au/business/financial-services/nab-labs-prepare-bank-for-the-future/news-story/d73e9b43cfca49e9f49a699f609d94b5

Le Masson, P., Weil, B., and Hatchuel, A. 2010. *Strategic Management of Innovation and Design*. Cambridge: Cambridge University Press.

Leonard-Barton, D. 1992. "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development," *Strategic Management Journal* (13:S1), pp. 111–125.

Levinthal, D. and March, J. 1993. "The Myopia of Learning," *Strategic Management Journal* (14:S2), pp. 95-112.

March, J. 1991. "Exploration and Exploitation in Organizational Learning," *Organization Science* (2:1), pp. 71-87.

Mascitelli, R. 2000. “From Experience: Harnessing Tacit Knowledge to Achieve Breakthrough Innovation,” *Journal of Product Innovation Management* (17:3), pp. 179-193.

Masoudnia, Y. and Szwejczewski, M. 2012. “Bootlegging in the R&D Departments of High-Technology Firms,” *Research Technology Management* (55:5), pp 35-42.

Miller, L. and Miller, R. 2012. “Classifying Innovation,” *International Journal of Innovation and Technology Management* (9:1), 18 pages.

Morrell, L. 2015. “Getting to the roots of what digital innovation means,” *Internet Retailing*. Available at: http://internetretailing.net/issue/digital-innovation-report-october-2015/getting-to-the-roots-of-what-digital-innovation-means/

O’ Reily, C. A., and Tushman, M. L. 2004. “The ambidextrous organization,” *Harvard Business Review* (82:4), pp. 74-83.

Peffers, K., Tuunanen, T., Rothenberger, M. and Chatterjee, S. 2008. ”A Design Science Research Methodology for Information Systems Research”, *Journal of MIS*, 24(3), 45-77.

PwC. 2015. “Innovation 1000 Study | Innovators and Spenders | Strategy.” Available at: http://www.strategyand.pwc.com/global/home/what-we-think/innovation1000/top-innovators-spenders#/tab-2010

Reilly, E. 2003. *Milestones in Computer Science and Information Technology*. Greenwood Press.

Rich, B. and Janos, L. 1996. *Skunk Works*. Boston: Little Brown.

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

Rothwell, R. and Gardiner, P. 1985. “Invention, Innovation, Re-innovation and the Role of the User,” *Technovation* (3:3), pp. 167-168.

Sekhar, S.C. 2010. “Benchmarking,” *African Journal of Business Management* (4:6), pp. 882-885.

Tidd, J. and Bessant, J. (2009). *Managing Innovation Integrating Technological, Market and Organizational Change* (4th ed.). Chichester UK: John Wiley & Sons.

Van de Ven, A., Polley, D., Garud, R. and Venkataraman, S. 2008. *The Innovation Journey*, New York, NY: Oxford University Press.

Von Hippel, E. 2001. “Perspective: User Toolkits for Innovation,” *Journal of Product Innovation*, (18: 4), pp. 247-257.

von Hippel, E. and von Krogh, G. 2013. Identifying Viable "Need-Solution Pairs": Problem Solving without Problem Formulation. *DSpace@MIT*. Massachusetts Institute of Technology. Engineering Systems Division. Available at: http://hdl.handle.net/1721.1/82610

Vorhies, D.W. and Morgan, N.A. 2005. “Benchmarking Marketing Capabilities for Sustainable Competitive Advantage,” *Journal of Marketing* (69:1), pp. 80-94.

Yoo, Y., Henfridsson, O., and Lyytinen, K. 2010. “Research Commentary – The new organizing logic of digital innovation: An agenda for information systems research,” *Information Systems Research* (21:4), pp. 724-735.

Zittrain, J. 2006. “The Generative Internet,” *Harvard Law Review*, pp. 1974-2040.