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ORIGINAL ARTICLE

Experimenting and innovation: purposes, possibilities and preferred solutions

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ABSTRACT

This paper explores the range of purposes for experimenting and identifies some of the patterns and processes where experimentation leads to innovation. Thematic analysis of a brief overview of literature indicates that experimentation can be understood from multiple perspectives: as a mindset, a determination to solve a puzzle or challenge, a generic research process to develop new goods and services, to explore new fields and as a core process in creating desired futures. Experimentation will increase in importance as researchers and organisations explore dynamic and turbulent environments, seeking new avenues to generate and apply new technologies, and capture their benefits.

Keywords: Experiment, purpose, process, desired futures.

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INTRODUCTION

Experimenting and its links to innovation is a core notion in both physical and social sciences, and is largely understood as a foundation for future development. Some authors have a long history of investigating this notion and generating deep insights (Thomke et al., 1998, Thomke, 1998, 2001, 2003A, 2003B) providing clear principles of action for further application. Others also see experimenting as a mindset or an effective practice (Dyer et al., 2011), often closely aligned with learning and knowledge development, with little explicit articulation of the processes.

The many studies of experimenting have defined experimental processes and the steps undertaken to make progress in new or little understood fields (Franklin, 1981, 1990, 2016). However, multiple studies have largely examined experimentation and innovation from discipline based perspectives. This paper attempts to summarise our current knowledge regarding experimentation and its links to innovation to identify the core concepts from a range of approaches, and to overcome the potential bias of exploring only the outcomes of experimentation.

Using notions of purposeful systems and open systems theory (Ackoff and Emery, 1972, Emery 1997) and active adaptive behaviour (Emery, 1997, Matthews et al., 2011) we explore the purposes and processes of experimenting for innovation across a range of diverse contexts. We suggest that experimenting is an important activity in dynamic and changing environments where past knowledge may not be sufficient to guide behaviour in emerging conditions. We propose that experimenting is a purposeful activity associated with an experimental mindset and openness to new ideas, often directed at creating desired futures, where learning is a central component of the experimental process.

We seek to contribute to a broader understanding of experimentation through presenting a clearer indication of understandings of experimentation in multiple contexts. The research question we are considering is: How can we characterise experimenting and its links to innovation across multiple domains?

THEORETICAL BACKGROUND

The history of civilisation is soundly based on science and scientific progress that has benefitted from experimentation. One example is Gregor Mendel's experiments to gain insights into genetic influences in plant hybridisation and fruit flies and its application to agriculture and the cultivation of edible plants. The long history of experimentation to generate new products and new processes for innovation, is understood as research and development in medical and technological advances is understood as research and development.

Experimentation has been core to the development of scientific knowledge, and new advances in technology have been generated by scientists trained in the scientific methods, but also by amateurs seeking to achieve a specific goal such as the Wright Brothers and their development of a flying machine. Similarly, medical advances in identifying substances to treat disease, using naturally occurring substances as well as man-made pharmaceuticals are solidly based on a well-developed method of experimentation. Continued experimentation

through intense research development continues in these fields today

Experimenting covers a range of activities that could be an enquiry, a trial run, research, pilot, trial, tryout, test of some new ideas or a new context where such ideas can be explored. Experimentation can be a response to curiosity about certain phenomena, and result in certain forms of behaviours.

Close examination and reflection on these activities suggest that experimenting is largely associated with purposive actions and activities, often with clearly defined goals or objectives or puzzles to be solved. Achieving such outcomes is often a challenging and painstaking journey requiring planning, imagination, learning from multiple iterations and persistence.

Learning here refers to the cognitive processes by which individuals gain knowledge and understanding of relations between themselves and their environments (Ackoff and Emery, 1972). Individuals make choices, environments in which they make choices, the alternative courses of action available to them, and the outcomes of actions that are possible in the environments, all contribute to learning. Learning depends on characteristics of both the individual and the environment as shown in Fig. 1.

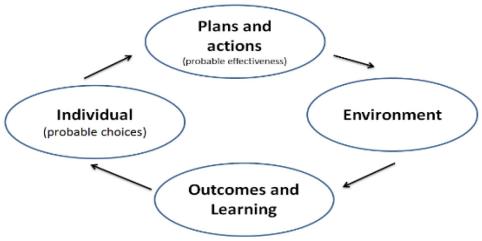

Fig. 1. Individual and Environment (Adapted from Matthews et al., 2011)

METHOD AND DATA

A brief review of research literature on experimentation was undertaken to gain information about the scope of its application. Not surprisingly a lot of literature described experimenting in contexts of science and scientific endeavour (Thomke, 1998, 2001, 2003B, Franklin, 1981, 1990, 2016, Tidd and Bessant, 2014). Other work described experimenting as a process undertaken by less skilled amateurs with an experimental mindset, focused on the end-user, or customer needs, who start with a personal goal they wanted to achieve and set out to accomplish the task. Examples include individuals with a passion and purpose to develop medical devices or prosthetics who shape their careers to overcome their personal physical challenges such as Van Phillips and the Flexi-Foot.

Careful reading of the literature identified a number of common patterns and processes from studies of experimenting and thematic analysis (Miles and Huberman, 1994) was used to develop data to identify common themes. Exploration of different representations of themes from context to process has been iteratively redrafted to focus on the purpose of experimenting.

RESULTS

Experimenting requires purpose, planning, and a set of processes. Planned carefully executed and clear instructions of experimental design are used to find ways of devising and conducting experiments to gain new knowledge or solutions from situations. Common understandings of experimenting include the notion that planning plays an important role in experimenting, however it is generally accepted that experimentation is not a linear process and many iterations are needed to develop and refine solutions.

In addition to purpose, planning, processes, experimenting benefits from an experimental mindset. The characteristics of this mindset have been described by studies of scientists who explored new possibilities, from Marie and Pierre Curie to the Wright Brothers. These characteristics are also found in tinkerers, practical people such as Edison, who explored new combinations. In particular, designers who work with multiple constituencies, and customer needs, take a holistic perspective and ask 'Why? Why not? And What If?' and go beyond existing solutions (Cross, 2011, Michlewski, 2015). Examples of idea generation, rapid prototyping and testing in new product development are well documented (Thomke, 2001, 2003A, Hargadon and Sutton, 1997). Designers also expand current perspectives and generate new solutions while creating desired futures.

Learning from 'naturally occurring experiments' can also trigger new methods, new knowledge and new learning. In this context, finding examples of positive performance or 'positive deviance (Pascale and Sternin, 2005) led to better solutions and learning by community members.

Other fields where experimenting is important include situations linked to continuous improvement and new and better processes (Deming, 2000) where streamlining and efficient processes can make large gains in performance and integration in manufacturing and services. Open innovation where external sources of information and expertise are brought to the company benefit the problem solving and experimenting are common in multiple contexts (Chesbrough, 2003).

Experimenting and exploring new possibilities in creating new projects and enterprises (Murray and Tripsas, 2004) or using the resources at hand to develop new enterprises (Baker and Nelson, 2005).

At a business level, some entrepreneurs are 'serial entrepreneurs' and constantly experimenting to gain more knowledge or information or power, applying industry recipes into new contexts for new enterprises. A consistent message from this diverse range of studies is the need for learning - learning from experimenting, learning by doing, learning from failure, and learning from interaction. These common themes were collected into a table, using criteria of purpose, content, context, process with indicative studies in Tab. 1.

Tab. 1 Examples of Dimensions of Experimentation

Purpose	What	Where/ Context	How	Papers
Explore new ideas and possibilities: create novel solutions	Experimental mindset; Design attitude	Any context: products, services systems	Questions: Why? Why not? What if? How might we?	Innovators DNA (Dyer et al., 2011,); Design Attitude (Michlewski, 2015)
Answer a question or solve a riddle	Research & development	Science, Medicine Health, Social Policy	Experimental design; Experimental methods	What makes a good experiment (Franklin, 2016) Experimentation matters (Thomke, 2003A)
Develop new products	New product development	Manufacturing, Medicine	Plan, develop and test with materials, design	Managing experimentation in design of new products (Thomke, 1998)
Develop new and better ways of creating value for customers	Service innovation; innovation in services	Professional services; health; banking	Rigorous five stage process with steps, desired outcomes, success measures,	R&D comes to Services: Bank of America's Pathbreaking Experiments (Thomke, 2003B)
Develop better and more streamlined and integrated processes	Increased efficiency, less waste, process innovation;	Lean manufacturing, business process management	Kaizen; Kanban	New Economics for Industry, Government, Education (Deming, 2000)
Develop novel and richer solutions to problems	Cross boundaries internally and externally for knowledge, ideas and problem solving	Business, science, research	Open innovation, incorporated new ideas from outside company	Open Innovation: New Imperative (Chesbrough, 2003)
Creating new projects and ventures	Entrepreneurship	Business, social ventures	Entrepreneurial bricolage;	Exploratory Processes of Entrepreneurial Firms[21] ; Creating Something from Nothing (Baker and Nelson, 2005)
Learning from natural experiments; Applying new learning in similar context	Explore new possibilities; new solutions Clinical trials; field trials	Medicine. Health; Agriculture	Observe, examine, test. Identify Positive deviance; learning driven field trials; solution identification	Your Company's Secret Change Agents (Pascale and Sternin, 2005)
Creating desired futures for mutual benefit	Explore new possibilities through co-design, collaboration	Architecture, living spaces, meaning	Design attitudes, mindset, tools: Improvisation, rapid prototyping, test	Design thinking (Cross, 2011), Design Driven Innovation (Verganti, 2009), Service Design (Stickdorn and Schneider, 2010)

DISCUSSION AND CONCLUSIONS

The brief review used in our investigation of how might we progress our knowledge and understanding of experimenting and its links to innovation, generated some interesting findings regarding the diversity of purposes, processes and practices where experimenting was used. Information presented in Tab. 1 indicates that broadly there appear to be three approaches. i) an experimental mindset which perceives situations as opportunities to explore; ii) a focus on a problem or puzzle to be solved, and iii) a view that we all have the potential to imagine and work towards desired futures, often co-creating and implementing new solutions.

Analysis of the results of our search found that experimenting includes more than scientific processes of research and development, and highlights the centrality of an experimental mindset that can look beyond what is

known and what can be seen, to explore new possibilities. Often the best new solutions are focused on the end user or customer, and iteration is central to an experimenting process, rather than the emergence of a neatly developed solution. We identified that experimenting as well as a purposive process and conduit to developing innovative solutions. Exceptions of the constraints and limitations of experimenting are known in situations of high reliability, such as airplane flights, medical emergencies, human health and well-being.

This initial investigation of experimenting using a brief search has limitations in terms of the degree of search and diversity of settings as other important and relevant studies may have been overlooked. This limitation can be overcome by a systematic exploration of literature, with a clear purpose and method. The research question we are considering is: How can we usefully characterise experimenting and its links to innovation across multiple domains?

We contribute to a broader understanding of experimentation and its contribution to innovation through presenting a clearer indication of the application and benefits of experimentation in multiple contexts. Specifically it highlights the importance of active engagement of individuals and teams in framing the questions and processes for the iterative journeys between experimentation and innovation.

Future directions for research might explore experimenting in the social sciences (Ehmke and Shogren, 2010), in experimenting and innovation that creates new meaning (Verganti, 2009) or in seeking answers to questions such as: to what extent is experimenting a pre-requisite for innovation? Or necessary for optimal outcomes? How can an experimental mindset be encouraged? To what extent is experimenting in situations of exploration similar or different too situations of exploitation? Experimentation and repeated iterations can be carried in laboratory exercises and practical settings. There is no doubt that experimenting will continue to be a focus of attention as we explore new forms of innovation in products, services and systems.

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