

# INNOVATION THROUGH GENERATIVE SYSTEMS DESIGN

Michel Avital  
Case Western Reserve University and  
University of Amsterdam

The bulk of the literature that covers the conditions conducive to innovative processes emphasizes the features of work environment that promotes one's creativity. For example, it argues that creativity is a consequent of motivation, autonomy, work settings, climate, workload, and personal characteristics (Amabile 1983, Amabile et al 1996, Stenmark 2005). Considerations also include wider scope determinants of innovation such as organizations vision (Swanson & Ramiller 1997), technological infrastructure (Broadbent et al 1999) or institutional factors (King et al. 1994). However, there is not much attention to the desirable features of IT-based systems in that context and particularly to requirements for systems that fit for innovative processes.

Building on the concept of *generative design*, I address this void by suggesting a set of considerations for designing systems that are conducive to innovative processes. More specifically, I propose that such systems should be evocative, adaptive and open-ended. This position paper presents these three design directives and takes a stab in extending them into operationalizable design features.

Generative design refers to the design considerations in developing systems or platforms that support and enhance *generative capacity*—that is the considerations in designing systems that are conducive to one's ability to produce new configurations and possibilities, to reframe the way we see and understand the world, and to challenge the normative status quo (Avital & Te'eni 2006). Thus, people's generative capacity is a key source of innovation, and by definition, generative design aims to encapsulate the design directives of systems that enhance and complement that capability.

The concept of generativity has been applied time and again in central theories of various disciplines—for example, in Psychology (Erikson 1950), Linguistics (Chomsky 1972), Organization Science (Schön 1979) and Computer Science (Frazer 2002). In general, being generative refers to having an evocative power or aptitude that can result in producing or creating something (Weick 2007), or tapping into a source of innovation (Cook & Brown 1999). In our context, the modifier "generative" denotes conducive to the production of something innovative. In other words, generative design refers the design requirements and considerations in developing information systems that augment people's natural ability to innovate.

Contrary to the common 'parametric design' in which a design target is predefined and can be parameterized, generative design is focused on the generation or discovery of new design alternatives in the form of disparate sets of evolving configurations. An earlier attempt to apply the concept was made by Frazer (2002) who presented *generative evolutionary design* for

computer-assisted generation of possible solutions for ill-defined or wicked problems. However, whereas John Frazer has focused on designing computers that can generate possible innovative solutions, this paper focuses on information systems that support people who aim to innovate. With fundamentally different underlying innovative agents (i.e., a machine vis-à-vis a person), the consequent system design requirements and considerations take a different path in each instance.

Other attempts to approach the underlying topic in IS research fall in the domain of creativity research and focuses on the effect of creativity support information systems on work in organizational settings. However, so far, in spite of the wide variety of possible tasks and desired creative outputs in organizations, their operationalization in IS studies has been often a certain decision-making task. Reducing all creative acts into decision-making tasks is problematic for two reasons. There are other kinds of task that requires creativity in the organizational context, let alone outside the organizational realm (e.g., design-oriented tasks). Furthermore, analytical decision-making is merely one part of a manager's job; the other part involves idea generation, form-giving, innovation design (Boland & Collopy 2004). Ironically, creativity support systems that one might believe are built primarily to enhance a syntactical process that resembles design thinking and attitude, have been treated in IS research as decision support systems that inherently focus on analytical processes.

## GENERATIVE DESIGN

It has been argued that people's generative capacity is a source of innovation and that generative design refers to the requirements or characteristic of (computer-based) systems that enhance and complement that capability (Avital & Te'eni 2006). In this position paper, I share insights regarding generative design considerations and their possible operationalization, as summarized in Table 1. Overall, I submit that generative design should be evocative, adaptive and open-ended.

### Generative Design is Evocative

A system with a generative design inspires people to create something unique. It evokes new thinking and enables them to translate their ideas into a new context. Information technology can help creating the environment or conditions that are prone to those insights by generating and juxtaposing *diverse frames* that are not commonly associated with one another within an underlying context (Sternberg 1998). There are several ways to generate or elicit diverse frames using information technology, as demonstrated below:

**Visualization:** Systems should incorporate human-centered visualization tools that enable seeing multiple dimensions (Shneiderman 2002). That is, 3-D digital images of physical objects and visual representations of various facets of less tangible parameters such as the characteristics of networks, hierarchies, processes, and the likes. Visualization provides the ability to see an object from multiple perspectives and to search for new insightful points of view.

***Simulation:*** Systems should incorporate human-centered simulation tools that enable testing an object or a process or part thereof in multiple situations. This refers to the underlying process or object's behavior, its dynamic capabilities or response to particular stimulus in different contexts (Gokhale 1996).

***Abstraction:*** Systems should incorporate human-centered abstraction tools that enable examining objects or processes at multiple degrees of granularity. Increasing or decreasing granularity enables one to separate between the situated features of a task or object and the fundamental characteristics that define it. The ability to move swiftly between levels of granularity is essential for identifying emergent patterns, commonalities, and anomalies (Srinivasan & Te'eni 1995).

***Integration:*** Systems should incorporate human-centered integration tools that enable aligning exclusive yet related domains, objects, or processes in multiple overlay configurations. Integration refers to one's ability to overlay or merge views of various parallel subsystems or crosscuts of objects that are associated with different core domains, disciplines, practices, or organizational units, and which are traditionally or institutionally unrelated. Supporting the ability to overlay traditionally unrelated subsystems or objects through integrated platforms provides much insight about interoperability between heterogeneous systems and promotes system-wide boundary crossing, across-the-board sharing and cross-fertilization (Boland et al. 1994).

***Communication:*** Systems should incorporate human-centered communication tools that enable sharing of multiple points of view. In this case, communication refers to one's ability to talk and share information with other actors and stakeholders with no regards to institutionally imposed boundaries. Communication tools enable cross-fertilization through sharing of information, participative action, ad-hoc and ongoing cooperation, and collaborative work practices (Wasko & Faraj 2000). An extended notion of communication tools includes ubiquitous access and fast connectivity to shared knowledge-based repositories.

## **Generative Design is Adaptive**

A system with a generative design can be used by a diverse set of people in their own respective environments and for various tasks within an intended scope. It is adaptive with respect to the type of users or groups it serves in diverse problem spaces. It is also simple to understand and easy to master by anyone. Information technology can help creating evocative systems or platforms that are flexible yet powerful to enable the generation of new configurations. Two main IT-enabled features drive the systemic flexibility and adaptivity that are required for generative design, as follows:

***Customization:*** Systems should incorporate tailorable facilities and customization tools that enable user-induced adaptation (Mackay 1991, Tam & Ho 2006). As it is impossible to design systems that fit all users and all situations, tailorable facilities affords systems

where one's actions are not dictated through narrowly defined rules of engagement or training on how the technology ought to be used. In contrast, using built-in customization tools allows users to play an integral role in the modification of the technology in the context of its use. Technology tailoring should be a native concept in generative design to allow users to redefine continually the services they need and to customize it according to the use patterns of their choice.

***Automation:*** Systems should incorporate artificial intelligence that enables system-induced adaptation (Weiser 1993). Although customization tools provide much value, they also require users' attention in response to change in use pattern, environment and the like. Designing adaptive systems that incorporate continuous learning and improvement based on codified use patterns and other performance measures allows users to shift resources from system operations to generating the desired outputs.

### **Generative Design is Open-Ended**

A system with a generative design can virtually generate infinite number of configurations. It is inherently open-ended because it is evocative and because it is adaptive. That is, by design, generative design already provides the foundations for generating endless configurations by many. Information technology can help enhancing regeneration and future configurations, and thus contribute further to the long-term vitality and sustainable fit of the underlying systems. Two IT-enabled features enhance open-endedness that characterizes generative design, as follows:

***Peer-production:*** Systems should incorporate peer-production facilities, that is, the means that enable any individual or group to produce and share at their own volition new and useful extensions of products or services (Schultze et al 2007). Peer-production promotes innovation through collective action that yields chains of uncoordinated successive evolutionary changes in response to market demands and emerging opportunities. Peer production becomes possible only in a technological environment that is designed a priori with extensible architecture and a social environment that affords the necessary incentives and normative support. For example, the architecture of Internet browsers encourages the development of plugins or add-ons by unaffiliated third parties, and the architecture of Wikipedia encourages contributions of knowledge objects and a stream of continuous updates and refinements. Both platforms are examples of an extensible architecture and a design strategy that counts on peer-production for continuous development and growth.

***Rejuvenation:*** Systems should incorporate a modular architecture in support of renewal processes. Renewal refers to building an integrative path for continuous fine-tuning as well as radical innovation. The degree of modularity pertains to the embedded reconfigurable flexibility of its components and corresponds to the inherent coupling among them. For example, open-source applications are designed with a modular architecture that affords easy reconfiguration and upgrade path.

In summary, systems that are conducive to innovative processes should be evocative, adaptive and open-ended. These design requirements and possible operationalization thereof are summarized in the following table.

<b>Generative Design Directive</b>	<b>System Feature</b>	<b>Description</b>
System should be Evocative	Visualization	Incorporate tools that enable seeing an object from multiple perspectives
	Simulation	Incorporate tools that enable testing an object or a process or part thereof in multiple situations
	Abstraction	Incorporate tools that enable examining objects or processes at multiple degrees of granularity
	Integration	Incorporate tools that enable aligning exclusive yet related domains, objects, or processes in multiple overlay configurations
	Communication	Incorporate tools that enable sharing of multiple points of view and support of cross-domain exchange
System should be Adaptive	Customization	Incorporate tailorable facilities and customization tools that enable user-induced adaptation
	Automation	Incorporate artificial intelligence that enables system-induced adaptation
System should be Open-ended	Peer-Production	Incorporate an extensible architecture that enables anyone to produce and share at their own volition new and useful extensions of products or services
	Rejuvenation	Incorporate open development standards, easy upgrade path and a modular architecture in support of renewal processes

**Table 1.** Generative Design Directives and Respective Features

## CONCLUSION

Generative design is particularly relevant for promoting innovation—it has the potential to evoke a capacity for rejuvenation, a capacity to produce infinite possibilities or configurations, a capacity to challenge the status quo and think out-of-the-box, a capacity to reconstruct social reality and consequent action, and a capacity to revitalize our epistemic stance. Generative design can help ordinary people to achieve extraordinary results.

## ACKNOWLEDGEMENT

This position paper is part of a larger body of work that has been developed with Dov Te'eni.

## REFERENCES

- Amabile, T.M. (1983) *The Social Psychology of Creativity*. Springer-Verlag, New York.
- Amabile, T.M., Conti, R., Coon, H., Collins, M. A., Lazenby, J. & Herron, M. (1996) Assessing the work environment for creativity. *Academy of Management Journal*, 39, pp. 1154-1184.
- Avital, M. and Te'eni, D. (2006) "From Generative Fit to Generative Capacity: Exploring an Emerging Dimension of Information Systems Fit and Task Performance," *Proceedings of the 14<sup>th</sup> European Conference on Information Systems*.
- Boland, R.J. & Collopy, F. (eds) (2004) *Managing as Designing*, Stanford, California: Stanford University Press.
- Boland, R.J., Tenkasi, R.V. & Te'eni, D. (1994) "Designing Information Technology to Support Distributed Cognition," *Organization Science*, 5(3), pp. 456-475.
- Broadbent, M, Weill, P. & Clair, D.S (1999) "The Implications of Information Technology Infrastructure for Business Process Redesign," *MIS Quarterly*, 23(2), pp. 159-182.
- Chomsky, N. (1972) *Language and Mind*, New York: Harcourt Brace Jovanovich.
- Cook, S.D.N. & Brown, J.S. (1999) "Bridging Epistemologies: The Generative Dance Between Organizational Knowledge and Organizational Knowing," *Organization Science*, (10) 4, pp. 381-400.
- Erikson, E.H. (1950) *Childhood and Society*, New York: W. W. Norton & Company.
- Frazer, J. (2002) "Creative design and the generative evolutionary paradigm." In P.J. Bentley and D.W. Corne (eds.), *Creative Evolutionary Systems*, San Francisco, CA: Morgan Kaufmann Publishers, pp. 253-274.
- Gokhale, A.A. (1996) "Effectiveness of computer simulation for enhancing higher order thinking," *Journal of Industrial Teacher Education*, 33 (4), pp. 36-46.
- King, J.L., Gurbaxani, V., Kraemer, K.L., McFarlan, F.W., Raman, K.S. & Yao, C.S. (1994) "Institutional factors in information technology innovation," *Information Systems Research*, 5(2), pp. 139-169.
- Mackay, W. (1991) "Triggers and barriers to customizing software," *Proceedings of the CHI '91 Conference*, New Orleans, Louisiana.
- Schön, D.A. (1979) "Generative Metaphor: A Perspective on Problem-Setting in Social Policy." In A. Ortony (ed.), *Metaphor and Thought*, pp. 254-283, Cambridge: Cambridge University Press.

- Schultze, U., Prandelli, E., Salonen, P.I. & Alstyne, M.V (2007) "Internet-Enabled Co-Production: Partnering or Competing with Customers?," *Communications of the Association for Information Systems* (19) 15, pp. 294-324.
- Shneiderman B. (2002) *Leonardo's Laptop: Human needs and the new computing technologies*. The MIT Press.
- Srinivasan, A. & Te'eni, D. (1995) "Modeling as constrained problem solving: An empirical study of the data modeling process," *Management Science*, 41(3), pp. 419-434.
- Stenmark, D. (2005) "Organisational Creativity in Context: Learning from a Failing Attempt to Introduce IT Support for Creativity," *Journal of Technology and Human Interaction*, 1(4), pp. 80-98.
- Sternberg, R.J. (1988) *The Nature of Creativity: Contemporary Psychological Perspectives*, New York: Cambridge University Press.
- Tam K.Y. & Ho, S.Y. (2006) "Understanding the Impact of Web Personalization on User Information Processing and Decision Outcomes," *MIS Quarterly*, 30(4), pp. 865-890.
- Swanson, E.B. & Ramiller, N.C. (1997) "The Organizing Vision in Information Systems Innovation," *Organization Science*, 8(5), pp. 458-474.
- Wasko, M.M. & Faraj, S. (2000) "It is what one does: why people participate and help others in electronic communities of practice," *Journal of Strategic Information Systems*, 9(2-3), pp. 155-173.
- Weick, K.E. (2007) "The Generative Properties of Richness," *Academy of Management Journal*, 50(1), pp. 14-19.
- Weiser, M. (1993) "Some computer science issues in ubiquitous computing," in Back to the Real World, Special issue on Computer Augmented Environments, *Communications of the ACM*, 36(7), pp. 75-84.