Disruptive Innovation Strategy Effects on Hard-Disk Maker Population: A System Dynamics Study

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ABSTRACT

To encourage premium-quality information systems (IS) research in areas where dynamic complexity rules, this article combines disruptive innovation strategy (DIS) theory with the system dynamics (SD) modeling method. It presents a computer simulation model of the hard-disk (HD) maker population overshoot and collapse dynamics. Data from the HD maker industry help calibrate the parameters of the SD model and replicate the HD makers’ overshoot and collapse dynamics, which DIS allegedly caused from 1973 through 1993. SD model analysis entails articulating exactly how the structure of feedback relations among variables in a system determines its performance through time. The analysis of the HD maker population model shows that, over five distinct time phases, four different feedback loops might have been most prominent in generating the HD maker population dynamics. The article shows the benefits of using SD modeling software, such as iThink®, and SD model analysis software, such as Digest®. The latter helps detect exactly how changes in loop polarity and prominence determine system performance through time. Strategic scenarios computed with the model also show the relevance of using SD for IS research and practice.

Keywords: complex systems; disruptive innovation; feedback loops; innovation diffusion; IT industry; system dynamics; technology adoption

INTRODUCTION

Disruptive innovation is emerging as a mainstream strategy that firms use first to create and subsequently to sustain growth in many industries (Bower & Christensen, 1995; Christensen, 1997; Christensen, Johnson, & Dann, 2002; Christensen & Raynor, 2003). For example, Honda’s small off-road motorcycles of the 1960s, personal computers, and Intuit’s accounting software initially under-performed established product offers. But such innovations bring new value propositions to new users who do not need all the performance incumbent firms offer. After establishing themselves in a simple
application or user niche, potentially disruptive products (goods or services) improve until they “change the game” (Gharajedaghi, 1999), driving incumbent firms to the sidelines.

Christensen and Raynor (2003) see disruptive innovation strategy (DIS) not as the product of random events but as a repeatable process that managers can design and replicate with sufficient regularity and success once they understand the circumstances associated with the genesis and distinct dynamics a DIS entails. Similarly, Christensen et al. (2002, p. 42) urge technology managers adept in developing new business processes to design robust, replicable DIS for creating and nurturing new growth business areas. In so doing, they must (a) seek to balance resources that sustain short-term profit and investments in high-growth opportunities and (b) use both separate screening processes and separate criteria for judging sustaining and disruptive innovation projects.

Anthony and Christensen (2004) and Christensen et al. (2002) argue that it is extremely important for technology managers to understand DIS. To help make it so, this article shows a SD model that replicates Christensen’s (1992) data on HD maker population dynamics. The model draws on archetypal SD overshoot and collapse work (Alfeld & Graham, 1974; Mojtahedzadeh, Andersen, & Richardson, 2004), which covers SD models in many areas with similarities in the structure of causal processes.

Cast as a methodological IS industry case, the article also shows the use and benefits of model analysis with Mojtahedzadeh’s (1996) pathway participation metric (PPM), implemented in his Digest® software (Mojtahedzadeh et al., 2004). Shown here is a small part of a modeling project that combined DIS theory with SD to answer specific client concerns about the dynamic consequences of implementing disruptive innovation strategies in established high-technology markets that contain over- and under-served (current and potential) users.

By definition, DIS is a dynamic process. Any model that purports to explain the evolution of a dynamic process also defines a dynamic system either explicitly or implicitly (Repenning, 2002). A crucial aspect of model building in any domain is that any claim a model makes about the nature and structure of relations among variables in a system must follow as a logical consequence of its assumptions about the system. And attaining logical consistency requires checking if the dynamic system the model defines can generate the real-life performance of the dynamic process the model tries to explain.

But most existing DI models are merely textual and diagrammatic in nature. Given a particular disruptive innovation situation, in order to determine if a prescribed DI idea can generate superior performance, which only “systemic leverage” endows (Georgantzas & Ritchie-Dunham, 2003), managers must mentally solve a complex system of difference or differential equations. Alas, relying on intuition for testing logical consistency in dynamic business processes might contrast sharply with the long-certified human cognitive limits (Morchcroft, 1985; Paich & Sterman, 1993; Sastry, 1997; Sterman, 1989).

Aware of these limits, this article makes multiple contributions. One is the culmination of the early disruptive innovation literature into a generic model of the hard-disk makers’ overshoot and collapse. Using a generic structure from prior SD overshoot and collapse work, the model contains assumptions common to seemingly diverse theories in economics, epidemiology, marketing and sociology. Two is the translation of these seemingly diverse components into a computer simulation environment addresses the specific concerns of a real-life client by generating the overshoot and collapse dynamics of the hard-disk makers’ population.

Furthermore, the article aims to expand the relative scarce but insightful IS research using the SD modeling method (Abdel-Hamid & Madnick 1989; Dutta & Roy, 2005; Kanungo, 2003). By describing the SD method and demonstrating its value, the paper encourages a wider adoption of the SD modeling method in information systems research.
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