J. Eng. Technol. Manage. 33 (2014) 174–192

Contents lists available at ScienceDirect

Journal of Engineering and Technology Management

journal homepage: www.elsevier.com/locate/jengtecman

Disruptive innovations in complex product systems industries: A case study

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ARTICLE INFO

Keywords:
Complex product systems
Disruptive innovation
Case study
Copper production

ABSTRACT

We propose that disruptive changes pertaining to complex product systems (CoPS) will yield a different set of characteristics than those traditionally observed for commodity products, and seek evidence for this proposition in a case study of the Flash Converting technology, a disruptive CoPS innovation in the copper production industry. Our results show that unlike disruptions in commodity product industries, the incumbent CoPS technology does not overshoot mainstream market performance demand. Also, the disruptive CoPS innovation; (i) is not nurtured in low-end niche markets, (ii) initially satisfies mainstream market performance demand, and (iii) has higher unit price than the incumbent technology.

Introduction

CoPS (complex product systems) are customized, one-off or small batched capital goods items, which are high in complexity and value (Autio et al., 1996; Miller et al., 1995). Examples of CoPS include telecommunications systems, air traffic control systems, aircraft engines, offshore oil equipment, and weapon systems. Scholars who have advanced this literature propose CoPS to form a generic category of industrial products, distinct from mass-produced commodity products such as cars, semiconductors, and consumer electronics (Hobday, 1998), and which can absorb a significant percentage of a nation's industrial investment (e.g. Barlow, 2000). Moody and Dodgson (2006), for

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http://dx.doi.org/10.1016/j.jengtecman.2014.06.002
0923-4748/

example, assert that 11% of the value added GDP (gross domestic product) of a nation is attributed to CoPS. Similarly, Acha et al. (2004) report the CoPS share of the United Kingdom GDP for manufacturing and construction has been 19% at the end of the 1990s. But more importantly, CoPS have a significant impact on other product categories as well. For instance, machines used in high-volume production processes can often be classified as CoPS, thus forming the underpinning of many commodity products (Moody and Dodgson, 2006).

Since the seminal works of Miller et al. (1995) and Hobday (1998), the literature studying CoPS has focused on several themes, including the competencies and capabilities of CoPS firms (Bergek et al., 2008; Hardstone, 2004; Hobday et al., 2005; Prencipe, 1997, 2000), inter-organizational collaboration and knowledge management within CoPS projects (Barlow, 2000; Brusoni and Prencipe, 2001; Chen et al., 2007; Marshall and Brady, 2001; Ngai et al., 2008), the learning ability of project-based firms in successive CoPS projects (Barlow, 2000; Prencipe and Tell, 2001), the adoption and diffusion of CoPS (Baraldi, 2009; Inoue and Miyazaki, 2008), and innovations within CoPS projects (Magnusson and Johansson, 2008). There is, however, a shortage of literature focusing on industry change and in particular changes that are brought about by discontinuities in the CoPS context. Bergek et al.'s (2008) examination of the dynamics of change and shakeouts in the gas turbine industry, and Hardstone's (2004) study of the effects of CIM (computer integrated manufacturing) in offset lithographic printing and publishing, offer rare investigations of radical change in CoPS.

In this paper we aim to contribute to the literature by studying disruptive technological changes (Bower and Christensen, 1995; Christensen and Rosenbloom, 1995; Christensen and Bower, 1996; Christensen, 1997b) in CoPS industries. Although prior research demonstrates the possibility of disruptive change in CoPS settings, such as in steel making and kidney disease treatment (Nair and Ahlstrom, 2003), the exact manner of disruption is not explicated. Our objective is therefore to reveal the characteristics of disruptive change that are applicable for CoPS, which can at the same time provide firms positioned in CoPS industries important strategic indicators of disruptive change. To this end, we undertake a case study of a complex product system to observe the characteristics of disruptive change. While our case study cannot statistically verify the manner of disruption in CoPS settings, it nonetheless provides evidence toward a more comprehensive understanding of this phenomenon.

Our empirical study focuses on the Flash Converting technology, a CoPS innovation that is integrated into copper smelting facilities and used in one of the key processes that increase the purity of copper. Introduced into the copper production industry in 1995, the Flash Converting technology is emerging as a disruptive innovation as it displaces the incumbent Peirce–Smith converter, particularly in new green-field investments, by not only satisfying the customer's output performance requirements, but by also providing additional benefits such as significantly lowering emissions and improving total online availability (Kojo et al., 2009). Through semi-structured interviews with key respondents from the innovating firm, together with complementary secondary data, we assess the characteristics of disruptive change in this CoPS context by comparing our empirical observations with the traits of disruption established from a review of Christensen and his co-author's works that typically focus on commodity products.

The paper is organized as follows. We begin with a theoretical review of CoPS and disruptive innovations, and then synthesize these discussions by developing propositions connected with the characteristics of disruptive change in the CoPS context. Next, we describe our case study methodology, and in turn, discuss the case study results in light of our developed propositions. We conclude our paper with a discussion of the theoretical, managerial, and policy implications, as well as considerations for future research.

Theoretical background

Complex product systems

The literature defines complex product systems (CoPS) as technological systems high in complexity and value, which are produced as customized, one-off or small batched capital goods items (Hobday, 1998; Miller et al., 1995). Examples of CoPS include: