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From imitation to innovation: The discursive processes of knowledge creation in the Chinese space industry

Jianxiang Bi [a], David Sarpong [b,*], David Botchie [c], Rekha Rao-Nicholson [d]

[a] Bristol Business School, University of the West of England, Frenchay Campus, Bristol BS16 1QY, United Kingdom
[b] College of Business, Arts & Social Sciences, Brunel Business School, Brunel University London, Kingston Lane, Uxbridge UB8 3PH, United Kingdom
[c] Bournemouth University Business School, Bournemouth University, Fern Barrow, Poole BH12 5BB, United Kingdom
[d] Newcastle University London, 102 Middlesex Street, London E1 7EZ, United Kingdom

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ABSTRACT

The quantum jump from ballistic missiles to space docking in recent decades symbolizes China's new product innovation potential in technologically complex industries. Drawing on theories of knowledge creation and discourse, we explore how the discursive practices of imitation, adaptation, and the reconfiguration of competitors' technologies help transform China from a duplicative assembler to a dynamic innovator in the global space industry. To this end, we argue that the processes of imitative knowledge-creation through oral, written, and gestural texts underpin China's new product innovation in the space industry. This innovation mechanism adopted by China, we found, involves discursively constructed ensembles of in-house knowledge generation for specialization in the production of space related products in context of high complexity and uncertainty. Discourse among sanctioned innovation actors in the industry, we argue, serve as a vital source of knowledge for integrating learning, strategic assets, and expertise to meeting the evolving needs of sole end-users. We conclude with some implication of our study to the theory and practice of imitability and transferability of knowledge and innovation in technologically complex industries.

1. Introduction

China's space industry has come to represent a symbol of Chinese knowledge-creation processes and new product innovation in technology-intensive industries (Nolan and Zhang, 2003; Medeiros, 2005; Logan, 2007). Following the footsteps of their western competitors, the Chinese space industry has made a quantum jump from developing narrowly defined ballistic missiles to space docking and a mix of broad dual-use technologies. However, the Chinese space industry is built on a distinct administrative heritage and processes reflecting the impact of historical events, decisions, and unique actions of the country's upper echelons (David, 1985; Grant, 1996; Sydow et al., 2009; Vergne and Durand, 2011). These historically conditioned decisions and actions, we observe has enabled (and impeded) the industry in accessing new ideas and limited a selection of innovation choices (Djelic and Quack, 2007; Von Foerster, 2009; Vergne and Durand, 2011; Koch, 2011). Yet, we know very little about how the dynamics of the Chinese space industry which is made up of a cluster of state-owned enterprises, business partners, specialized suppliers, service providers, and associated institutions (Foo et al., 2015; Medeiros, 2005). In particular, we have a very limited understanding as to how the 'nascent' Chinese space industry managed to develop the capabilities that allowed it progress and transition from an imitator to an innovator given that other potential 'latecomers' probably find themselves locked out in accessing promising knowledge and technologies in this complex and complicated industry (Nelson and Winter, 1982; Trebat and De Medeiros, 2014). (See Tables 1 and 2.)

As the Chinese space industry gains stature and legitimacy, the search practices and mechanisms it employs to pin-point knowledge relevant for innovation and developing novel space products that meet growing demand on performance, capacity, and reliability, has come under intense scrutiny (See: Trebat and De Medeiros, 2014; Gao et al., 2015). A vast body of literature suggests that the Chinese space industry thrives on knowledge creation approach in which foreign competitors technologies are reverse-engineered, mimicked, or explicitly copied (Cheung, 2011; Heymann, 1975; Hu et al., 2008; Pollpeter, 2011). This strategy, we follow Leloglu and Kocaoglan (2008) to argue reduces uncertainties and risks associated with the sequential phases of idea generation, design, engineering, prototype development, and testing. Accordingly, innovation scholars have become particularly interested in understanding how the industry through its imitative strategy leverages distant knowledge in explorative and exploitative ways (Savina et al., 2017), to compete successfully in this

* Corresponding author.
E-mail addresses: Jianxiang.Bi@uwe.ac.uk (J. Bi), David2.Sarpong@uwe.ac.uk (D. Sarpong), David.Botchie@open.ac.uk (D. Botchie), Rekha.Nicholson@uwe.ac.uk (R. Rao-Nicholson).

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Table 1
Summary presentation of data collection.

Types	Names	Years	Total
Private letters	Qian Xuesen	1956–2000	37
Semi-structured interviews	Senior managers	2010	5
Semi-structured follow-up interviews	Senior manager	2012	5
Internal documents	Manned spacecraft office	2010	8

technologically complex industry (Brockhoff and Guan, 1996; Leloglu and Kocaoglan, 2008).

We contribute to this body of knowledge by accounting for the transformation of China from a duplicative to a dynamic innovator in the space industry. In doing this, we draw on discourse and knowledge-creation as a meta-theoretical lens to explore the linkages between imitation and innovation, and how the discursive processes and structures of its knowledge-creation strategy has contributed to enhancing China's technological capabilities and innovation. We argue that the discursive processes of knowledge-creation through oral, written, and gestural texts undergirds the acquisition, absorption, and the transfer of knowledge driving Chinese space product innovation. In other words, we concur that the processes from imitation to innovation involve discursively constructed ensembles of in-house knowledge generation for specialization in the production of space products, which makes the late comer a vibrant competitor in the context of high complexity and uncertainty. We focus on internal bulletins (2010), private letters (1956–2000), and unstructured interviews (2010 and 2012) with leading protagonists in the Chinese space industry. Our discursive process approach offers an alternative explanation on how discourse could shape and give form to the creation, transfer, and utilization of technical knowledge to drive innovation in technologically complex industries. The research question driving our empirical inquiry, therefore, is: How does the transition from imitation to innovation in the Chinese space industry come to be identified, labelled and judged within the discourse of knowledge creation?

The paper is organized as follows. First, we provide a brief review of the literature on knowledge-creation and discourse to explore the discursive processes of knowledge generation through imitation to innovation. Next, emphasizing the historical context of the Chinese space industry, we outline our analytical approach to capture the logic and transfer mechanisms of knowledge innovation to drive our empirical inquiry. Following, is our research methodology, after which we present our findings. We conclude with a discussion of our findings and its implications for imitability and transferability of knowledge and innovation in technologically complex industries.

2. Knowledge-creation, conversion and transformation

Knowledge, a 'justified true belief', is context specific in time and space (Nelson, 1991; Nelson and Winter, 1982; Nonaka, 1994; Nonaka et al., 2000; Spender and Grant, 1996; Teece et al., 1990). Knowledge, therefore, is a dynamic and relational process of justifying personal beliefs, and an aspiration for truth by following a set of rules to reason and test (Foucault, 1971; Philp, 1985; Nonaka, 1994). Highlighting the critical nature of knowledge, Polanyi (1966) contends that 'we can know more than we can tell'. At the core of this argument was Polanyi's effort to define and make a clear-cut distinction between what constitute tacit (intuitive and unarticulated) knowledge and explicit (codified) knowledge. Because tacit knowledge lacks extensive codification or falsification and can only be acquired through experience, the knowledge of scientists, for example, cannot be fully reduced to a clearly articulated set of rules, axioms, and statements (Gertler, 2003; Howells, 2000; Nonaka and Takeuchi, 1995). By contrast, explicit knowledge can be abstracted, understood, and shared without a knowing subject. In other words, it is tested and codified, as in manuals and blueprints (Fagerberg et al., 2005; Lam, 2000; Popper, 1970).

Nonaka (1994) argue that knowledge creation occurs when explicit knowledge, in essence, grounded in tacit knowledge dynamically interacts in organizationally useful ways. Critics of Nonaka's spiral theory on knowledge creation, however, points out that a limitation this does not explain how tacit knowledge held by individuals is justified and converted into explicit or organizational knowledge or vice versa by the way of construction and reconstruction over time for innovation (Easterby-Smith, 1997; Gourlay, 2006). By contrast, Grant (1996) acknowledges the importance of transferability by maintaining that there are two forms of knowledge: knowing how and knowing about, which reflect their tacit and explicit nature; and the major distinction between them lies in transferability and the mechanisms for transfer across individuals, space, and time, if not transforming tacit knowledge. In an effort to bridge this transferability gap, Nonaka and Takeuchi (1995) observe that tacit knowledge is by nature unarticulated and tied to the sense, movement skills, physical experiences, intuition, or implicit rules of thumb, while explicit knowledge is uttered and captured in drawings and writings (Nonaka and Von Krogh, 2009). Despite the contestations characterizing the distinction between the transferability of the two basic forms of knowledge, the nature of knowledge as articulated by these scholars' remains relational, dynamic, and humanistic, and the logic of knowledge creation is fundamentally the mobilization of individual tacit knowledge to reinforce the interaction with explicit knowledge.

The processes of knowledge creation at the organizational level, as argued by Grant (1996) include four stages: transferability, capacity for aggregation, appropriability, and specialization in knowledge acquisition, through which the firm is to integrating the specialist knowledge resident in individuals into goods and services. The crucial point of knowledge management is to maintain the balance between creation and application. Similarly, for Nonaka and Toyama (2003), the spiral processes of socialization, externalization, combination, and internalization (SECI) as a vibrant driver transcend time, space, and organizational boundaries to shape knowledge creation and utilization functions for innovation. The processes of creation, conversion and transformation by nature are about knowledge sharing and transferability through either daily business interaction or hands-on experience. This shared

Table 2
Knowledge-creation and new innovation in the space industry.

Program	Knowledge	Organizational Mechanism	Innovation
Missiles 1956	Knowledge creation Missile knowledge based on US and Soviet models	Engaging in discourses on missile knowledge diffusion Identifying core missile technologies	Ballistic missiles
Dual-use technologies 1986	Knowledge conversion Dual-use knowledge based on US and European practices	Engaging in discourses on dual-use knowledge diffusion. Identifying core dual-use technologies	Spin-on dual-use technologies
Spacecraft 1992	Knowledge transformation Spacecraft knowledge based on US space shuttles and Russian spacecraft	Engaging in discourses on space knowledge diffusion Identifying Russian spacecraft technologies	*Shenzhou* spacecraft