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Revealing dynamics and consequences of fit and misfit between formal and informal networks in multi-institutional product development collaborations

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Dedicated to Oskar Gruen a pioneer in empirical research of large multi-institutional projects.

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ABSTRACT

The study presents a longitudinal examination about dynamics and consequences of fit and misfit between formally ascribed design interfaces and informal communication networks in two large multi-institutional product development collaborations in space industry. Findings: (1) formally ascribed design interfaces and informal communication networks correlate only marginally. The main reason is that informal communication is much more dense than ascribed; (2) although the formally ascribed design interfaces change, the structure of informal communication remains largely stable throughout time; (3) the most intriguing finding is that this communicational misfit is associated with higher effectiveness, but, it negatively impacts the institutional unit's efficiency.

1. Introduction and overview

In today's fast-paced, knowledge-intensive environments, multi-institutional product development collaborations have become a popular vehicle for executing innovative efforts and serve as an inevitable answer to environmental and market developments (Oxley and Sampson, 2004). The exponential growth in knowledge is likely the most prominent driving factor for the increasing number of multi-institutional product development collaborations. In addition as product development and research become increasingly multidisciplinary, research managers and policy-makers are relying more on multi-institutional collaborations to develop strong, intellectually diverse projects that can answer complex research questions (Carley et al., 2006). Multi-institutional product development collaborations are large-scale projects consisting as building block of units dispersed over a number of different institutions and most often also over a number of different countries. Engineering technically advanced and complex products requires tapping into and capitalizing on knowledge concentrated in pockets of excellence around the globe (Leenders et al., 2003). As recent research exemplifies the number of multi-institutional product development collaborations and their size exponentially grows in many business sectors (e.g., Carley et al., 2006; Carlsson, 2006; Roijakkers and Hagedorn, 2006). Researchers and practitioners unanimously agree that effective management

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plays a critical role in ensuring the success of multi-institutional product development collaborations (Pinto and Prescott, 1988). However, most managerial concepts and knowledge in the field of new product development refer to smaller-scale projects consisting of a single (or few) project unit(s) within a single institution. This obvious deficiency may be responsible for a 'performance paradox' as Flyvbjerg et al. (2003) stress: "At the same time as many more and much larger infrastructure projects are being proposed and built around the world, it is becoming clear that many such projects have strikingly poor performance records . . .." (p. 3) (see also Gruen, 2004; Morris and Hough, 1987).

Today, it is common practice to manage the embedded knowledge in product development by using a stage-gate new product development process (e.g., MacCormack et al., 2001). In employing a stage-gate approach, new product development processes are usually modeled by dividing design activities into a number of sequential phases or stages and separating the stages by milestones called gates (e.g., Cooper, 1990; Ulrich and Eppinger, 2004). Although the number of phases or stages differ, most stage-gate processes contain the same activities—conceptualization, design, and integration (e.g., MacCormack et al., 2001). In the early conceptual phases of the design process, the design space is likely to be very large and complex (Dym, 1994). In order to reduce this complexity, a hierarchical decomposition procedure is used to break down the design task into semi-independent sub-tasks corresponding to the functional components of the planned product (Simon, 1996). In executing the design tasks in multi-institutional product development collaborations, most commonly a number of units distributed over the involved institutions are responsible for designing the components of the final product (Sosa et al., 2004). In the later integration stages, after completion of the unit-specific tasks, the project break-down structure reverses, thereby forming a hierarchical 'recomposition' of the project. The managerial process of 'breaking down' the project into components, and its subsequent reversal, can be visualized and managed using the design structure matrix framework of Steward (1981). The 'Design Structure Matrix' (DSM) framework is a managerial tool used to address and define the unit-specific interfaces within the collaboration and their dynamics throughout the stages of new product development (Hellström, 2005; Yassine et al., 1999). The unit-specific interfaces represent product component related dependencies, which inherently create the requirement of interrelated design activities. For example, an electric shaver is composed of six main functional parts or components, the protection cap, the shaving unit, the driving unit, the power supply, the housing assy, and the cover assy. There are different degrees of dependencies between these components (Oosterman, 2001). The driving unit and the shaving unit have certainly strong dependencies and exemplify a strong interface, the dependency between power supply and shaving unit is weaker and can be characterized as weak interface, whereas the power supply and the protection cap have no direct dependencies, thus no interface. Subsequently interfaces can be rather weak or strong reflecting the required extent of the unit's mutual design adjustments or absent indicating that there is no requirement for mutual design adjustments.

The dynamical changes throughout product development phases highlight the importance of addressing and defining the interfaces between product components at the design and integration phases; it is also important to determine if the units actually interact according to their formally ascribed interfaces, an inevitable requirement for the collaborations to function (e.g., Dahl and Pederson, 2004; Thompson, 1967; Galbraith, 1973). Unfortunately, informal communication networks often compete with aspects of organizations as formal structure (Cross et al., 2002). One of the most consistent findings in the social science literature is that who you know often has a great deal to do with what you come to know (e.g., Granovetter, 1973; Burt, 1992; Rogers, 1995; Szulanski, 1996). In multi-institutional product development collaborations, therefore, it would be naïve to expect a perfect alignment between design interfaces – the 'Design Structure Matrix' (DSM) – and the informal communication network – the 'Informal Communication Matrix' (ICM) – as Sosa et al. (2004) have shown.

These considerations raise the following research questions:

(1) How strongly do the ascribed design interfaces (DSMs) and informal communication networks (ICMs) overlap?
(2) How do the ascribed design interfaces and informal communication networks, and their overlaps, change when the process moves from the design phase to the integration phase?
(3) What are the reasons for possible alignments and misalignments of DSMs and ICMs?
(4) What consequences do alignments and misalignments have for goal achievement?
(5) How can the management alignments and misalignments of DSMs and ICMs and goal achievement be brought into balance?

Obtaining answers to these questions is of major importance to improving the management of multi-institutional product development collaborations because it allows concurrent balancing of the formal organizational structure, as mirrored in the DSMs, and the informal organizational structure, as reflected in the ICMs, throughout phases of new product development. In addition, answering these questions broadens the base of systematic research and empirical data on large multi-institutional collaborations, as suggested by Gruen (2004), and it supplements the work of Sosa et al. (2004). Our paper contributes to the field of innovation management by offering new insights and explanations for the very nature and dynamics of multi-institutional product development collaborations. Because there are few empirical and theoretical insights into the functioning of such projects, our study is organized in an exploratory and a testing part. In the first part of the study we explore the dynamics of formal and informal networks in multi-institutional product development organizations. In this part we are unable to formulate explicit hypotheses based on the present knowledge. In the second part examining the consequences of the revealed network dynamics