Journal of Information Technology (2004) 00, 1–10

palgrave-journals.com/jit

Special edition

# Information flow structure in large-scale product development organizational networks

Dan Braha[1,2], Yaneer Bar-Yam[2]

[1]Earle P. Charlton College of Business, University of Massachusetts, North Dartmouth, MA, USA;
[2]New England Complex Systems Institute, Cambridge, MA, USA

**Correspondence:**
**D Braha, Faculty of Engineering Sciences, Ben-Gurion University, Israel.**
**E-mail: braha@necsi.org, dbraha@umassd.edu**

**Abstract**

This paper analyzes the statistical properties of real-world networks of people engaged in product development (PD) activities. We show that complex PD networks display similar statistical patterns to other real-world complex social, information, biological and technological networks. The paper lays out the foundations for understanding the properties of other intra- and inter-organizational networks that are realized by specific network architectures. The paper also provides a general framework towards characterizing the functionality, dynamics, robustness, and fragility of smart business networks.
*Journal of Information Technology* (2004) **0**, 000–000. doi:10.1057/palgrave.jit.2000030
**Keywords:** large-scale design; product development; socio-technical systems; information systems; social network analysis; complex engineering systems



## Introduction

On February 1, 1997, a major fire swept through one of Aisin Seiki's plants supplying brake fluid proportioning valves (or P-valves) to all Toyota vehicles manufactured by Toyota-group plants in Japan (Reitman, 1997; Nishiguchi and Beaudet, 1998). The sole reliance of Toyota on Aisin Seiki's supply and the low inventory levels of the P-valves inventory due to a just-in-time (JIT) operating environment threatened to shut down Toyota's 20 auto plants in Japan for weeks and damage local economies. Surprisingly, Toyota's car factories succeeded to recover their operations in only 5 days after the fire. The admirable Toyota's quick recovery can be attributed to the cohesive network structure of suppliers working with Toyota directly and indirectly. This enabled Toyota to reconfigure rapidly the supply chain network and pull together 36 suppliers, supported by more than 150 subcontractors, who produced small batches of P-valves on nearly 50 separate improvised tooling systems and production lines (Reitman, 1997). The above supply chain disaster recovery illustrates the importance of coordination and collaboration among supply chain partners (e.g., manufacturers, suppliers, and retailers) as a means for achieving greater strategic and operational value to the organization. Today, supply chain integration is further realized by complex business-to-business interactions via information technology, most importantly the Internet (Kambil and van Heck, 2002). In such supply chain networks, partners are involved in an intricate web of information transfer such as demand data, inventory status, and shipment schedules.

The usefulness of understanding organizational network structure as a tool for assessing the effects of decisions on organizational performance has been illustrated in the social science and management literatures (Cross *et al.*, 2002). There it has been shown that informal networks of relationships (e.g., communication, information, and problem-solving networks) – rather than formal organizational charts – determine to a large extent the patterns of coordination and work processes embedded in the organization (Cross *et al.*, 2002). In recent years, networks have also become the foundation for the understanding of numerous and disparate complex systems outside the field of social sciences (e.g., biology, ecology, engineering, and internet technology; see Albert and Barabási, 2002; Newman, 2003).

The goal of the this paper is to examine, for the first time, the statistical properties of an important large-scale information network – new product development – and discuss their significance in providing insight into ways of improving the strategic and operational decision-making of the organization. In general, information networks constitute the infrastructure for exchanging knowledge that is