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The Virtual Factory: Discontinuous Work in a Virtual Organization

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The Virtual Factory: Discontinuous work in a virtual organization[1]

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The Virtual Factory is an organized network for regional cooperation in the manufacturing industry in the region around Lake Constance, on the border between Germany, Switzerland and Austria. The network was developed through a collaborative action research project started by the Institute for Technology Management, University of St. Gallen[2]. Project leadership (the core partners) came from entrepreneurs and senior managers from companies in the region and four researchers from the Institute[3].

The Virtual Factory project

The researchers at the Institute for Technology Management wanted to study new forms of organization in industry, in particular networks of cooperating firms. Analysis before the start of the project led the researchers to believe that existing theories only partly addressed the managerial issues raised by the changing role of information technology and globalization of industries. Furthermore, they believed that descriptive research designs would be insufficient to bring to light the possibilities raised by these changes, since none of the local firms were involved in the kind of cooperative ventures they imagined. Instead, the project would need to develop and experiment on its own network. To implement the network, organizational development activities were carried out by the project sponsors in all participating companies and involved members at all organizational levels.

The initial goal of the project was to increase capacity utilization of existing resources (mainly machine tools) through technology-mediated cooperation between firms. The idea was to identify firms with comparable technologies in precision mechanical manufacturing but in industries with uncorrelated demand, and connect them through an on-line market. A firm that faced a high level of demand in its industry could reduce its lead-time by using the excess manufacturing capacity of another firm in the

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1 This description of the Virtual Factory project draws from an unpublished paper by Bernhard Katzy and Kevin Crowston.

2 The Institute for Technology Management, University of St. Gallen is headed by Professor Günter Schuh. Financial support for the project was provided by The Swiss Commission for Scientific Research (KwF) and the Virtuelle Fabrik partner companies.

3 Bernhard Katzy, Kai Millarg, Thomas Zehnder, Stefan Eisen and Åsa Göransson.

network temporarily facing lower demand. Companies with lower demand could cover some of the fixed cost of their equipment by taking in such work.

As it developed, the network was also successful with products that were not fully specified, and for which the firms could also use their substantial engineering capabilities. For example, consider the development of the electric retraction device for a steering wheel, a product engineered and built within the Virtual Factory. The manufacturing project started when one of the network members, Wiftech, was approached by a customer and asked if they could provide the part. Wiftech itself did not have the capacity to build the part, but offered instead to take the project to the network. Wiftech passed the project on to a project leader from another firm, with whom they were acquainted from various project meetings. The project leader evaluated ten different technologies from ten independent firms in the network for technological feasibility and for their cost in the effort to design the part, an example of marshalling competencies. While ten companies were involved in the search for a technical solution, only three were involved in designing and manufacturing the first prototypes. Final production required different partners, as the order quantities did not fit the one-of-a-kind manufacturing philosophy of the prototype manufacturers.

In terms of our framework for virtual work, the Virtual Factory was virtual because it spanned two kinds of discontinuities: between firms and across multiple projects. Engineering, prototyping and production involved different firms, and the mix differed for each project. In other words, a different virtual factory was assembled from the competencies of the members firms in the network for each project opportunity, as shown in Figure 1. The issues in and the mechanisms used to manage the two kinds of discontinuities will be discussed in turn.

Discontinuities in firm

A key intervention the project was increasing the ability of firms to co-operate with partners in the network. There was a realization that the business processes in place in most companies would not allow efficient and rapid co-operation across firm boundaries, which was necessary to meet the rapidly changing demands of the turbulent environment. For example, one partner was interested in using the laser machining capabilities of another. To test these capabilities, they sent the company an order for about US $50 worth of work. The order bounced between sales, engineering and manufacturing for about three weeks, annoying all parties, as it became apparent that there was no process for handling such orders.

A second issue was developing mechanisms to marshal competencies, that is, to determine what competencies and from which partner companies are required for a specific customer’s request at hand. Initially, the plan was to follow the suggestions of Miles and Snow (1986). The network sponsors would

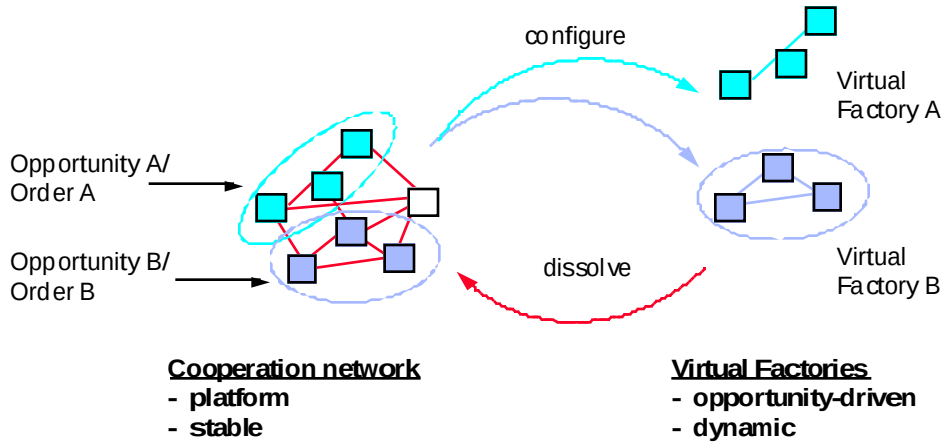

Figure 1. Establishment and Management of Co-operation (Göransson, 1997).

provide a database recording the capabilities of each partner company (a so-called "full-disclosure information system") and to rely on market mechanisms to coordinate the placement of work. A shift towards market coordination through computer systems also concurs with the predictions of transaction cost economics (Williamson, 1975; Malone, et al., 1987).

The information system in the project Virtuelle Fabrik served its purpose until the proposed addition of real-time capacity information for remote allocation. At that point action reflection revealed that managers of the partner companies were not prepared to make out-sourcing decisions solely on the basis of the information in this database. This was especially true for many of the intangible competencies developed in the network (e.g., engineering, integration competencies) which could not be described as succinctly and unambiguously as the physical resources (i.e., a particular model of machine tool). A simple database of such competencies was out of the question in any case. Instead, managers opted for inserting the name, address and phone and fax number of the directly responsible operator or industrial engineer in the database. Based on the mutual knowledge of partners' competencies that they had acquired during the project meetings and site visits, managers chose to use personal contact to directly settle technical issues. In fact, the database was basically regarded as a means to establish a first contact (yellow pages), while placing orders was based on the personal contact, thus limiting the role of the database. Kumar, et al. (1996) report a similar failure of an information system for transaction management in the Prato region of Italy. They attribute this failure to a mismatch between the economic rationality of the system and the need of the mangers to build trust and a relationship with the companies with whom they interacted.

Discontinuities in project

A second set of project interventions focused on the technical and organizational problems that arose when setting up new co-operations between multiple partners in the network. The researchers analyzed early experiences of manufacturing projects to identify problematic situations. Small teams of managers and researchers then developed what the project partners called the “rules of the game”. Each rule was presented to all Virtual Factory partners and a formal vote taken on adding it to the set of guidelines for collaboration. These guidelines eventually covered the entire lifecycle of a co-operative manufacturing project and concerned for example how partners are selected, how prices are calculated co-operatively, a checklist of how to specify customer products, and a standard contract.

As well, the project members defined a set of standard roles in a manufacturing project. Because manufacturing projects are discontinuous, a single firm can be involved in multiple ones at different stages. Two firms might be competing to work on one manufacturing project while cooperating on another. In such situations, firms were not sure what to expect from each other when they worked together. This situation was confusing for the researchers and for the managers as well and there was felt to be an emerging risk of manufacturing project failures from misunderstandings. At the same time, researchers observed that firms had started to specialize in specific coordination activities involved in the process of recombination. For example, a firm might take the lead in identifying what competencies a particular product required and which other firms could provide them, without doing any of the engineering or manufacturing itself.

In this phase of the project, the researchers initially drew on the emerging literature on the network form of organization to describe the complementary roles and positions of cooperating partners. Miles and Snow (1986) identified the broker as a central role to take the lead in marshalling necessary competencies from different firms. Again the literature did not provide much detail on the processes by which this cooperation and recombination happened. Some authors have suggested that mere market forces alone will be sufficient. Diagnosis of the manufacturing projects inclined researchers to base their action planning instead on the necessary managerial competencies for business growths. Consideration of these functions led to the specification of a set of roles to ensure that the skills needed for a successful manufacturing project were provided. One firm might fill different roles (or even multiple roles) for different manufacturing projects, as long as it was clear who was responsible for each role and all were filled.

In summary, the experiences of the Virtual Factory reveal a number of issues and approaches to managing discontinuous projects involving partners from a discontinuous set of companies. To manage work discontinuous across multiple firms required the development of internal routines for taking and giving work and network routines for marshalling competencies. To manage work discontinuous across processes required the development of formal rules and roles for work in the network.

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