



Analysis of global manufacturing virtual networks in the aeronautical industry

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ABSTRACT

The evolution of organizations that work in multinational environments has considerably altered their production strategies. One of the consequences has been the appearance of Global Manufacturing Virtual Networks (GMVNs), which include all kinds of enterprises and production centres and establish a new type of horizontal collaboration and relations between independent companies and even competitors who establish occasional collaborations on projects they could not take on individually. This paper analyses the causes behind the formation of such networks, their strategy, structure, dynamics and evolution, taking into account areas such as strategic intercompany alliances, synchronization of their value and supply chains, their information systems, the cultural aspects of the organizations in question and, finally, their convergence with another of the more relevant future trends in production: mass customization. The proposed model shall be applied to the aeronautical industry which is one of the industries which has developed the GMVN concept. The case study of the engine manufacturer Rolls Royce will provide a better understanding of the evolution of its strategic positioning, as well as the dynamic and fluent nature of its virtual relations. This will demonstrate its effectiveness by clarifying and putting these organizations in perspective and analyzing their evolution over the next few years.

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1. Introduction

Today, the concept of plant or production centre is becoming increasingly more ambiguous. In many industries, there is growing collaboration between production centres and manufacturing networks that seek to respond to market demands more efficiently and obtain competitive advantages in an increasingly globalized environment. In some industries, such as the aeronautical industry, the electronics industry or the car industry, there is mention of Global Manufacturing Virtual Networks (GMVNs) based on a new manufacturing architecture model with a high development potential to satisfy an increasingly demanding and fragmented market. In short, these networks represent a compendium of the new tendencies within the production organization, such as global manufacture, strategic alliances, flexible production and mass customization.

The purpose of this study is to analyze how GMVNs appear in the market and evolve in the future by considering their main characteristics that will determine their strategy positioning through a period of time. Some special tools will be proposed to study this strategic decision that will determine the starting point of the GMVN building process. Subsequently, another network

features and their potential evolution will be considered to achieve a better understanding of how and why these organizations work. For achieving that purpose a case study about the engine manufacturer Rolls-Royce will be developed by analyzing already established and known facts on a new perspective that permits to have a comprehensive understanding about GMVNs. The initial descriptive approach about GMVNs, mostly developed in Section 5, based on the new perspective given by the conceptual models defined in Figs. 2 and 5 will permit to gain a broad understanding about how these organizations work. Finally sub-Section 5.3 and Section 6 give some prescriptive propositions about how GMVNs should work and evolve in the future to be efficient.

The environment in which enterprises currently work with increasingly globalized markets, company consolidation and strategic alliances is forcing companies to find new forms of collaboration to improve the integration and synchronisation of the various functions and stages of their product value chain (Zhao et al., 2001). Global manufacturing virtual networks allow companies to focus on their core competences, maintaining their participation in the design and manufacture of complex integrated systems. These networks can be considered as extended manufacturing systems where various companies can co-operate on a specific project whose result is the manufacture of a product or the provision of a service and where each company is expert in one or more of the areas that give the product its value (Elmuti and Kathawala, 2001).

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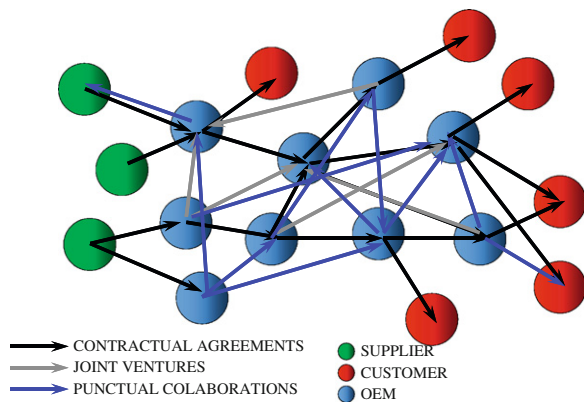


Fig. 1. Structure of global manufacturing virtual networks.

Although there are hardly any theoretical models or studies on how these networks function, they are known to develop on a large scale and involve a complex number of participants that include enterprises, organizations and institutions covering several countries or even continents. The implications in the various manufacturing fields are manifold and knowing how they are structured, how they coordinate and plan their needs and implement their supply chain management, what their specific competences are and how the different members of the network communicate shall be some of the features this paper seeks to clarify. In addition, market demands for increasingly customized products and services lead to the implementation of new manufacturing techniques such as mass customization, where the complexity of the implementation, the information flow or the planning of resources complicate the management of this type of network even further. Fig. 1 gives a simple example of the structure of this type of network, together with the relations between the nodes.

2. Literature review and theoretical background

First studies about multi-plant organizations started by the early 1980s. These works were principally based on location criteria. When a network structure was implanted each factory was considered as an independent centre ignoring the network structure (Schmenner, 1982) and potential synergies. During these years, even though globalization of markets started to rise, operations and production organization studies were only concerned about independent manufacturing centres.

In the late 1980s and early 1990s, due to the intense growing demand of global markets, many companies seriously considered the benefits of manufacturing networks interconnected. A number of scholars have approached network manufacturing research from different perspectives: Shi et al. (2003, 2005), Hanna (2007), Rudberg and Olhager (2003, 2008) and Demeter (2003) assessed these organizations from a strategic approach. Shi and Gregory (1998) analyzed the interdependence of manufacturing centres where all matrix connexions were considered. Khurana and Talbot (1999) studied how each factory could influence one to each other in a network structure. Ferdows (1997), Sturgeon (2000, 2002), Kulmala et al. (2002), Williams et al. (2001) and Colotla (2002) focused on structural issues. Yusuf et al. (2004), Arshinder et al. (2008) and D'Amours et al. (1999) analyzed their communication systems and Sturgeon (2002) surveyed the cultural aspects of these networks.

First manufacturing networks were constituted by a number factories dispersed geographically to obtain certain competitive advantages like access to low production costs, qualified labour

and proximity to strategic markets (Ferdows, 1997 and Bhutta et al., 2003). Anyhow, all these manufacturing centres were mostly owned by one or very few companies. Thus the "virtualization" degree of the network was very limited. It is understood that the virtual component of the network is related to the intensity of the collaborations with companies external to the organization itself (Shi and Gregory, 2003). This is the case of DEC where Arntzen et al. (1995) analyzed how digital equipment corporation redesigned its network including the relocation of some of its nodes at a corporate level. Other relevant studies about manufacturing networks with low "virtualization" are Acer (Mathews and Snow, 1998), Procter & Gamble (Camm et al., 1997) or Hewlett Packard (Lee and Billington, 1995).

Li et al. (2000) were the first to name global manufacturing virtual networks by proposing a strategic positioning model for these organizations based on three vectors: globalization, strategic alliances and value and supply chains. These networks are more complex structures formed by several companies and several production centres based on horizontal and vertical relations among independent companies or even competitors that establish punctual collaborations in projects they could not afford individually (Tuma 1998). In some industries such as aeronautics (Shi et al., 2005), electronics (Shi and Gregory, 2003) or the automotive industry (Sturgeon and Florida, 2000), global manufacturing virtual networks (GMVN) has become a growing phenomenon with a high potential for development in order to satisfy an ever more demanding and fragmented market (Shi and Gregory, 2003).

During last years, many authors have studied this new phenomenon of virtual organizations (eg.: Corvello and Migliarese, 2007; Manthou et al., 2004; Offodile and Abdel-Malek, 2002). Other relevant works about GMVNs were made by Johansen and Comstock (2005) who analyzed the production strategy change of the aeronautical manufacturer SAAB AERO to join the Airbus manufacturing network. Meixell et al. (2004) studied the convergence of these organizations with mass customization systems and Williams et al. (2001) surveyed the relations among supply chain members and offset strategies in the global aerospace sector.

During last years, many scholars have approached GMVNs phenomenon from different perspectives to achieve a detailed understanding of some network features like their structure, information systems or alliance models. Anyhow, some research fields need further development like collaborative strategies among network actors or cross-cultural attributes at network level. Future works should also deep into a comprehensive understanding of all GMVNs features and their interdependence. By understanding the main building blocks of these organizations and their management processes, it will be possible to formulate a strategy and design process for developing effective GMVNs in the future.

3. Research design and methodology

This paper is a part of a research work about GMVNs modeling. The starting point has been a survey during six years (1999–2005) to the most relevant engine manufacturing plants within the aeronautical industry in Europe. Data was collected through a number of visits to the most relevant facilities in Europe: Volvo Aero (Trollhättan, Sweden), SNECMA (Evry-Corbeil, France), MTU (Munich and Hannover, Germany), GE Aero (Caledonian, UK; Eskiseir, Turkey), ITP (Zamudio and Ajalvir, Spain), IAI (Israel) and Rolls-Royce (Hillington, UK; and Oberursel, Germany). Methodology used based on the research terminology of Yin (1994) has been exploratory and descriptive based on a case study with

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