Vlerick Leuven Gent Management School

the Autonomous Management School of
Ghent University and Katholieke Universiteit Leuven

Vlerick Leuven Gent Working Paper Series 2009/15

THE DYNAMIC MANAGEMENT OF MANUFACTURING NETWORKS

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D/2009/6482/16

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ABSTRACT

The structure and organization of international manufacturing has changed over the past twenty years. It seems as if manufacturing is moving towards emerging countries e.g. China or India, often to take advantage of lower labour costs. Whilst production cost is an important consideration in choosing a location for the factory, we argue that one should not become victim of a herd effect and that other parameters, such as quality, flexibility, transportation and energy costs need to be taken into consideration in the determination of the optimal manufacturing network. Relocating a factory is changing the strategic architecture of the company's manufacturing network and requires a long term view and a good model to design the architecture of the manufacturing network. Based on a longitudinal empirical study of eight European multinational companies we have gained an understanding of the dynamics of a company's manufacturing architecture. We observed that market entry drives the creation of new factories more than mere production cost, and that skills and knowledge can be a ticket for a safe future of the factory. Over ten years, we observed an increase in the knowledge sharing role of factories. And we also learnt that it is important to keep a significant variety of factories in order to provide flexibility in reshaping the strategic architecture of your manufacturing.

Key words: international manufacturing, network management, manufacturing architecture

INTRODUCTION

Over the last 10 years the international manufacturing landscape has changed significantly. We have seen a major shift in the allocation of production capacity across the world. Manufacturing as a percentage of GDP has been reduced in many of the industrialized countries. In the USA, for example, it has moved from 18.9% to 14.4 % of GDP in the period 1995-2005, in the UK from 21.7 to 14.4%, and in Japan from 23.4 to 21%. At the same time, manufacturing activities have risen in China, India or Brazil, in line with the overall growth of their economy. When translated to the level of an organization the shifts are in some cases much stronger. Some companies have massively invested in outsourcing, or transferred their manufacturing networks completely to low labor cost countries. A quick reading of the economic press may well suggest that manufacturing is moving massively towards emerging countries in search of lower labor costs in order to pursue cost reductions. But there may be other reasons. Some seem to shift their production towards emerging countries, because that is where the fastest market development is happening. An example of this is the Renault Nissan group, which is shifting its production towards countries like Romania, Iran and the Russian Federation.

In many cases, network reorganizations are driven by cost optimization. Whilst we acknowledge the importance of cost optimizations in a manufacturing network, we also strongly believe that the decision to relocate or close a factory should be taken within a broader perspective. Research on Manufacturing Strategy has argued consistently that factories are also sources of capabilities such as quality, flexibility, response time or reliability (Ferdows and De Meyer, 1992). Closing or opening a factory is a strategic decision, which will have an impact on the competitiveness of the company. The decision should therefore be taken with a strategic network perspective in mind.

Based on a longitudinal empirical study, we have been able to observe the dynamics of the factory network. The first stage of the study was an extensive survey of the factories of eight multinationals mainly based in Europe in 1995-1996. These companies were revisited in 2005-2006 and interviewed in order to discover the current architecture of the factory network. The study illustrated that the organization of manufacturing is indeed very dynamic. Whereas in the first round of our study, the eight companies had 59 factories, in the second round of our study, ten years later, about one third of the factories were either closed or sold, and roughly 40 factories had joined the company networks. Some of these factories were acquired, others were the result of mergers, and others again were greenfield projects.

We observed that the opening of the new sites was driven mainly by market entry. Compared to the mid-90s, we saw also in 2005-2006 a definite increase in the role of factories as sources of knowledge. We also found evidence of the need to keep agility in the factory networks, in order to be able to manage the dynamics of production over the years.

MANUFACTURING AS A NETWORK

How does one analyze the network of factories? The research on manufacturing strategy has given us some interesting models that can support a senior technology manager in the decision making about this network. Hayes and Schmenner classify factories according to their focus. This focus can be the market, the product or a step in the process. Market focused factories will be more responsive to customer needs. Product or process focused factories enable the company to benefit from specialization and to build on its capabilities (Hayes and Schmenner, 1978). The choice between these three dimensions of focus will depend on the characteristics of the industry. For example, one would expect food factories to be closer to the market, while chemical factories will rather be where capabilities can easily be exploited.

Ferdows (1997) argued that each factory has a specific and strategic role to fulfill for the organization: its role may for example be to serve a market, to act as a low-cost source of products or components, or to take the lead in the development and transfer of innovations. The concept of the lead factory, which shares its innovations and knowledge with other factories, suggests that multinational manufacturing companies are more than a set of isolated factories that exchange goods among each other.

In our own work we have extended and detailed this approach. A manufacturing network is often seen as a supply chain, with goods (components, semi-finished products or end products) flowing between the factories in the network. That is obviously a correct view. But such a network can also be described as a network of knowledge, with innovations and information flowing between the factories. We actually argue, similar to Doz, Santos and Williamson, that the strength of a multinational manufacturing company lies precisely in its potential to exploit its network of knowledge (Doz, Santos and Williamson, 2001). They use this idea with respect to the product and service innovations developed by the firm. We apply this network concept to process innovation and manufacturing. We have developed a model that classifies factories according to their role in this network of knowledge. We will discuss this model later in this paper.

As a consequence, we argue that the decision to change the status of a factory should take into account the role the factory plays in the knowledge network of the company. In closing or relocating the factory, one is changing the strategic architecture of the network. And this may well completely upset or even destroy the medium to long term equilibrium in the network in order to obtain short term gains. More specifically, we may be hurting the innovation flows in the network. This would be detrimental to the long term success of the network and the company. The question how to adjust the network need therefore to be answered on a strategic level.

ABOUT THE RESEARCH

The first phase: an in-depth survey in 1995-1996

In 1995-1996, we carried out an in-depth survey of all the factories of eight multinational manufacturing companies. The headquarters of these companies were all located in Western Europe. The confectionary producer Callebaut, now part of the global Barry-Callebaut group, was one of the cases, with manufacturing facilities in Belgium, the UK, Canada and the USA. Another interesting case has been Bekaert, producer of steel cord, which is a major supplier to the tire industry, with factories in Europe, Asia and the Americas. Yet another example was Samsonite Europe, producer of luggage, handbags, backpacks.

At that time, we conducted interviews with executives in manufacturing and supply chain functions in headquarters, and we sent questionnaires to the factory managers and their management teams in each of the factories in the multinational network. The conclusions drawn from this research were then discussed with many managers from many different companies, in many different industries in executive programs and during consulting projects. This study has allowed us to develop a model describing the position and the role of factories in the international manufacturing network (Vereecke et al 2002, and 2006).

The second phase: a round of in-depth interviews ten years later

In 2005-2006, we revisited these eight companies in order to understand how the network had evolved over time. In this second round of the research, in-depth interviews were conducted with one or two senior managers in the headquarters of each of the companies. In the interviews, based on a structured questionnaire, we presented some of the questions as well as some of the results of the previous study to these managers, and asked them to rate the factories again on their strategic role and their network position. A detailed description of the methodology as well as an overview of the results of this second phase of the research can be found in Vereecke (2007).

DESCRIBING OUR MODEL

Based on the 1995-1996 data, we were able to classify the factories in four broad though clearly distinct categories of factories, as is shown in Figure 1. The four categories differ mainly in the way factories relate to other factories in the network and/or with headquarters in terms of knowledge exchange.

Knowledge can flow between factories in different "formats". One important way is the transfer of innovations in the network. Indeed, an explicit flow of knowledge takes place whenever innovations developed in one site are transferred to and implemented in another factory in the network. A second and informal flow of knowledge occurs when managers of different sites talk to each other, or visit each other's site. Therefore, the level of communication between managers across factories has been measured, as well as the number of days manufacturing staff people from each factory have visited the other factories in the network. On the basis of such different types of knowledge flows we could distinguish four different types of factories (Vereecke, Van Dierdonck and De Meyer (2006)).

Insert Figure 1 About Here

The first category of factories consists of the "*isolated"* factories in the network. Few innovations reach this isolated factory and few, if any, innovations are transferred from here to other units; few manufacturing staff people come to visit such a factory, and in reverse also few manufacturing staff people from this factory go visit other factories. Moreover, there is little communication between the manufacturing staff people of this factory and the other manufacturing managers in the network. A producer of aluminum cans in our research had quite a few of these isolated factories. They were typically high performers, supplying commodity products to their local market, and relying on their own capabilities to improve their manufacturing processes. Some of them were green field factories, which ran in an efficient, reliable and independent way.

Somewhat similar to the isolated factories are the "*receiver factories*". They differ from the isolated factories on one aspect only: they receive quite a few innovations from other factories in the network and/or from headquarters. There can be a few different reasons for this 'injection' of innovations in the receiver factory. Some of these factories were underperforming, and needed external support to get the factory up to standard. Others were located so close to one of the sister factories, that they were run as 'satellite factories', under the supervision of the management team of the neighboring, typically larger, factory. Still other factories had to rely on external support to keep up to speed with rapidly changing technological innovation. A nice example in this respect was a state-of-the-art steel cord factory. This factory was the experimental unit in the network for the application of Computer-integrated Manufacturing. It was supposed to become the 'model factory' for the future, with zero defects and zero interruptions. In order to accomplish this, the factory received a lot of support from other factories and from development teams in the company.

The third category of factories is very different from the previous two. It consists of factories that have established strong network relationships. These network players show a high level of communication with other units in the network and they exchange a lot of innovations with the other units. They not only transfer innovations to the other factories, they also benefit from innovations developed elsewhere. Typical for these factories is that they are frequently hosting visitors from other factories in the network and from headquarters. This is why we have labeled them the '*hosting network players'*. Quite a few of the hosting network players in our research were the factory closest to headquarters. They thus automatically occupied a central position in the network. Some interviewees referred to this factory as the 'mother factory'.

An example of a hosting network player was the steel cord factory located about fifty kilometer from the Bekaert headquarters. This factory was very flexible, and produced a large range of products, for a broad geographical market; its location close to the technical development center in headquarters turned this factory into a prototype testing center; engineers from all over the world would go through training in this factory; finally, the factory was considered to be a center of excellence for part of the product range of the company.

We labeled the fourth category as '*active network players'*. The main difference between the hosting network players and this group lies in the intensity of communication and of innovation transfers, and the dominant direction of the flows of visitors. These are factories that communicate intensively with other units in the network; they actively share innovations with other units; and they are not only hosting visitors from other factories, their managers also pay a lot of visits to the other factories.

An interesting example of an active network player was a small Samsonite factory in Belgium, close to the product design center in the European headquarters. This factory was a pilot center for new designs of luggage. It compensated for its high labor cost by excelling in the production of small runs of new products, with short delivery times. When the new product matured, it was then transferred to low-cost factories in Eastern Europe.

FROM DESCRIPTION TO MANAGERIAL ACTION

The question with any set of categories is "so what?". How can one use this classification to help senior management to manage the strategic architecture of the factory network? Since the development of this model a decade ago we learned through lots of interactions with executives that it helps to answer two critical questions: what is the ideal network and what is the relation between the type of factories and geography? Let us examine each of these briefly.

1. How to achieve a balanced portfolio of factories

An important question for senior managers is how many of each type of factories they would like to keep in the network. Do they need factories of each type? Or are some types redundant, or even counter-productive in the competition?

Would it be possible for the company to survive without any network players? The answer is "no", since the innovations that come out of these networkers are crucial for the sustainable competitiveness of the company.

Hosting network players are the sources of innovations in the manufacturing network, and should therefore be part of the portfolio. However, the size of the factory may at some point in time create diseconomies of scale. Or the location of the hosting network player, which is often close to the headquarters or to where the roots of the company are, may not be the optimal location to tap into new trends. If this is the case, the need for some active network players will arise. This probably explains why large pharmaceutical companies, e.g. Novartis from Switzerland, have subsidiaries in California or Boston, where they are close to the development of know-how in biogenetic engineering.

But let's face it, network players are expensive factories. Their role as developers and distributors of knowledge implies a need for investments and resources. Being networkers probably even implies some inefficiency. Their managers spend a lot of time traveling, the visitors in their factories "disturb" the normal operations in the factory, training takes time, networking also means time in meetings and other forums where information is shared. As a consequence, these factories should be allowed some slack capacity to be able to fulfill their role of hosts and network players. It wouldn't be wise to allow for such inefficiencies in all factories.

Therefore, the network players should be complemented with some isolated factories, which are run in a very lean, efficient and low cost way, as such safeguarding the overall cost of the manufacturing network. Moreover, isolated factories offer strategic flexibility to the network. In case of a geographical expansion into new markets, these isolated factories can be used as the bricks in building the international manufacturing network. Copying the concept of a factory and replicating it in distant markets provides an easy and rapid way to start serving these distant markets and maybe even to start sensing trends in these markets, which may then stimulate the development of innovations in the network players. This idea of "copy/paste factories" is especially typical for companies with low value density products and mature process technologies. A can producer, for example, will "copy/paste" similar factories all over its geographical market.

Also, relocating isolated factories is relatively easy; it implies nothing more than a relocation of capacity. The shift in production in the textile industry illustrates this point. Over a period of roughly ten to fifteen years, textile producers have shifted production from North Africa or Mexico, over Mauritius, to Bangladesh, and finally China. "Picking up" the machinery and moving it to another country seems to be a relatively easy job.

Relocating network players is probably much more difficult. Their capability to serve as developers of knowledge may well be rooted in their location close to sources of knowledge or close to some specific expertise. For example, they may have a tight link to the R&D center of the company, or they may be located in a region with a long tradition of the company's industrial activity. When Tupperware decided to build new facilities for its Belgian production, it could have decided to build the greenfield factory in a low labor cost country. However, management decided to build the new factory only a couple of kilometers away from the old facilities. The reason? It was the know-how of its workforce, and the proximity of R&D which allowed for interaction between design and manufacturing and for experimentation on the shop floor. Another example are automotive producers e.g. Daimler Chrysler. This company will probably always have some manufacturing facilities in the "golden triangle" for automotive design and production between Stuttgart, Mulhouse and Torino, because of the blend of knowledge available in this area, through sophisticated suppliers, universities specializing in research on the automotive industry, machine construction, and design labs. Yet at some point in time, automotive companies may want to understand trends in Japanese car factories, which may give them a need for active network players to tap into this knowledge. The Japanese Nissan factories in the Renault network may well have taken on the role of an active network player that brings Nissan's knowledge in process engineering into the Renault network. Daimler Chrysler tried to do the same with Mitsubishi Motor Company, but has failed to take advantage of this venture.

The same argument goes in favor of receiver factories. We need them in the network, for the same reasons as the isolated factories. For processes where technology is rapidly evolving, one probably needs receiver factories rather than isolated ones. The concept of the receiver factory is to be used if the factory has to keep up to speed with the latest technologies; the isolated factory is usually better suited for standardized production.

Ultimately, one may even consider outsourcing the activity carried out in the isolated factory. In doing so, the total cost may be reduced, provided the activity is taken over by a partner who has specialized in it. Such a move does not harm the innovation power of the network, since the factory isn't sharing any important knowledge with the other players in the network.

2. What is the relationship between type of factory and geography?

Is there some natural geographical 'preference' for each of the types of factories? Would it be the case that isolated and receiver factories are typically located in low-labor cost countries? And that network players are by definition found in industrialized countries? This, we have learned over the years, doesn't always reflect reality. Especially active network players could – and probably should - be located all over the world. The main question here is where interesting sources of knowledge are to be found. Tapping into a source of knowledge, and transferring this knowledge across the network, is the primary task of an active network player (De Meyer and Garg, 2006).

The story is different for isolated or receiver factories. Although in theory these factories can be located anywhere, presence in high wage countries is probably not sustainable. Imagine an isolated factory in a high labor cost country, such as Japan, Switzerland or Belgium. This factory has a competitive disadvantage vis-à-vis the other factories in the company's network. If the company runs into overcapacity, the decision to reduce capacity may easily go towards downsizing or even closure of this factory. In doing so, the company is simply "cutting out" capacity, without hurting any of its flows of innovation. The story would have been different if this factory were a network player. In this case, cutting capacity would also have meant cutting vital innovation flows, and therefore hurting the innovative capability and the competitiveness of the network.

One of the Belgian factories in our study is a good example. This factory acted as a receiver: expertise from other factories in the network and from headquarters was transferred to this factory in order to improve its performance. In reverse, however, the factory had no innovations or best practices that it could share with the other factories. In a period of downsizing, this factory was the first "victim" and was closed.

Consequently, there is likely to be some natural evolution for isolated and receiver factories in high wage countries. They either struggle for survival, or move towards lower wage countries.

THE DYNAMICS OF FACTORY NETWORKS

The discussion of the two previous questions suggests that factory networks should evolve over time and that this evolution should be aligned with the change in the context and the strategy of the organization. It also suggests that the future of a factory depends to some extent on its current network position. These observations made us decide to go back to the companies we studied in 1995-1996, to see how they had evolved since then.

This second round of the research clearly confirmed our expectation that companies and their manufacturing networks are very dynamic. Several companies had indeed changed significantly due to mergers and acquisitions. Their manufacturing networks had gone through rounds of rationalization and closing down of factories, acquisitions of other factories, and the start-up of greenfield factories.

The globalisation of the factory networks

Figure 1 and 2 illustrate the globalization of the manufacturing networks of these eight companies. In 1995-1996, the eight multinationals studied had all together 59 factories: 42 factories were located in Europe, spread over 14 different countries. The other 17 factories were spread over 10 different countries in East Asia and the Middle East, the USA and Canada, South Africa and Australia. (See Figure 2)

Insert Figure 2 & 3 About Here

By 2005-2006, the eight multinationals had in total 83 factories: 42 factories were located in Europe, spread over 13 different countries. The other 41 factories were spread over 18 different countries in East Asia and the Middle East, the USA and Canada, Africa and Australia. (See Figure 2)

It is clear that the past 10 years have been characterized by increased globalization: whereas in 1995-1996 the factory networks of the 8 multinationals were dominantly European with a few sites in other continents, they now have become truly global, at least in their manufacturing.

Of the 59 factories in the networks in 1995-1996, 18 had disappeared, while 40 new ones had joined the networks, either through acquisitions, or as greenfield factories. (See Figure 4). Of the 18 factories that have disappeared from the manufacturing networks since 1995-1996, most had been closed down. A few factories had been transferred to other companies; some were owned together with partners, with whom the partnership had been stopped.

Insert Figure 4 About Here

Location advantage changes over time

Clearly, the manufacturing networks are very dynamic. This raises the question what drives the closure of old and the location of new factories. To answer this question, we first needed to understand the advantage provided by the location of the factory. The managers were therefore asked to select the primary advantage for each of their factories from a long list of possible location factors, which were grouped into a few categories: the factory's proximity to suppliers, the availability of labor, the availability of skills and know-how, the factory's proximity to the market, a set of social or political factors, a set of factors related to competition, the availability of energy, and a few other factors. We refer to Exhibit 1 for this list of drivers for establishing or exploiting a factory.

Table 1 lists the primary advantage that was offered by the location of the 59 factories in the eight multinationals in 1995-1996. The table distinguishes two groups of factories; the ones that were in the network in 1995-1996 but since then have disappeared from the networks; and the "survivors", that is the factories that were in the network in 1995-1996 and still are ten years later.

Table 2 lists the primary advantage that is offered by the location of the 82 factories in the eight multinationals in 2005-2006. Again we distinguish two groups of factories: the same group of "survivors" that were already in the networks in 1995-1996, and the "newcomers" that have joined the networks since 1995-1996.

Insert Table 1 & 2 About Here

Market proximity clearly was and still is the dominant driver for the location of a factory. Only 8 of the 82 factories have labor cost as the primary driver for the factory location. Whilst this doesn't imply that only 8 factories are located in low-labor-cost countries, it does mean that the internationalization of manufacturing networks is driven more dominantly by a search for markets, rather than delocalization in search of low-labor cost. Our research thus confirms other studies which have shown that delocalization of factories purely for cost reasons is less important than is sometimes assumed (OECD 2006).

Table 1 suggests that proportionally less factories which have the market or skills and know-how as their main location advantage have disappeared; at the same time proportionally more factories which have labor cost as their main advantage have disappeared. And not surprisingly, three of the four factories for which no real location advantage could be mentioned in 1995-1996 have also disappeared.

Clearly skills, know-how and market proximity are stable location advantages. Low labor cost, and lack of any major advantage is a less stable condition for a factory to operate in.

More factories are acting as network players

Error! Reference source not found. shows the proportion of factories that act as isolated factories, receivers, hosting and active network players, compared to ten years ago.

Insert Figure 5 About Here

One of our most interesting observations is that over the past ten years, the proportion of active network players has increased, whereas the proportion of isolated factories has decreased. This may suggest that more factories today are considered as a source of know-how for the network, and thus as an asset for the company.

To some extent, this may be a natural evolution. Building network relations takes time. So, the longer a factory is in the network, the stronger its ties are with the other factories in the network. However, the detailed data reveal that time is not the only explaining factor. Underlying the shift from isolated to network players are two distinct evolutions.

Some isolated and receiver plants have disappeared over time; some others have actively developed into network players. Table 3 and Table 4 show the evidence of these two evolutions.

Insert Table 3 & 4 About Here

Table 3 shows that out of the ten factories that have disappeared from the networks since 1995-1996 only one was a network player. Nine out of the ten that disappeared were isolated or receiver factories.

A comparison of the group of survivors in Table 3 and Table 4 tells us that the category of the isolated factories has been shrinking. Seven of these isolated plants have moved into a different position. The category of the active network players on the other hand has grown substantially. Clearly, some of the isolated factories and possibly also a few receiver factories have over time developed into network players, especially active network players.

These results have to be interpreted with some care. In the 1995-1996 study the network position of the factories had been measured based on a comprehensive set of data, collected via the managers in headquarters as well as in the plants. In the 2005-2006 study, the network position has been measured through interviews with managers in headquarters only. Our results for 2005-2006 are based on their perception and judgment, while the results for 1995-1996 were based on perception as well as hard data. It could be that some of the factories have been classified as “active network player” because this seemed more desirable to the interviewee. On the other hand, we have clear indications that the level of inter-unit activity has indeed increased over the past ten years. Several interviewees have stressed the importance of networking, as can be witnessed from some of the comments they made during the interviews. (See insert 1) They mentioned many actions taken to stimulate the sharing of experiences and best practices: working groups, audit teams, physical and virtual meetings, visits to factories, the use of intranet systems and databases, and a focus on KPIs for benchmarking.

Insert 1
Selected comments about the networking role of factories

- "Active and hosting network players carry a lot of know-how. This is very "time constant". It is saved in the heads of people, and therefore has little mobility. But even know-how is perishable. Even factories that have the know-how need to upgrade themselves. In order to remain a network player, a factory should not react in a defensive way and rely on its know-how. The role of an active network player is a necessity for the future."
- "Working groups have been defined to identify learning opportunities across factories. It starts with identifying some quick wins to make the factories learn from the other factories. An investment plan has been drawn to bring all factories to the same level."
- "The company made a huge step compared to 1996. We have broken with this situation of the past (of receiver and isolated factories) which was the result of history, of the mix of different cultures, of people being shy and modest in what they could bring. The company's big success is that it has become a real open company. There are regular meetings by function (HR, production, quality, logistics), in headquarters or in the factories, every year. Some people have been transferred to the factories."
- "A best practices network/database has been developed, there are simple and shared KPIs to make comparison easy, there is an intranet system for sharing experience. These actions have turned us into a company of active network players."
- "We have regular meetings of the site managers, on a regional basis. These meetings mostly take place in one of the factories."
- "We have small teams of people in charge of process improvements. They visit a factory and audit a line in this factory, together with the person responsible at the site and with specialists from other sites. They analyse KPIs, they check how the line is controlled, and they compare with other sites. In doing so, best practices are identified and know-how is shared. It also stimulates competition between the sites. The goal of this practice is to reduce the cost with 5% each year. So in fact, there are no real isolated factories in the network."
- "There is more networking than in the past: a lot of traveling, but also many virtual meetings (conference call, telephone councils)."
- "In the past, the company considered know-how as very specific to each of the factories. Today, the company tries to benefit from the sharing of know-how. The factory starts to take a more active position: now and then, people from the factory travel to other factories to set up new lines."
- "The factory acts as a host: it shares innovations with other players in the network, its staff frequently visits other factories, and staff from headquarters frequently visits the factory."

During the interviews we also learned from several managers that the development of network relations was not a matter of luck. Rather, it was the result of a clear and explicit strategy, in some cases regarded as a necessity for survival of the company. Some comments in insert 2 may illustrate this.

Insert 2
Selected comments about the drivers for building network relations

- "There is strong pressure to make the factory play an active network role. The factory has to become a centre of excellence, but this takes time. Informal contacts need to grow in the short term."
- "The change has been imposed on us by the difficult business environment. (…) Moreover, it is the way competition works. We simply have no choice."
- "No doubt, all factories are network players now. If not, it would have been a disaster!"

Overall, we dare to propose that the companies in our sample have preserved their competitiveness by shedding some of the factories that did not contribute to the knowledge creation, and by committing a larger part of their network to knowledge creation. that does not mean that they got rid of all isolated factories or receivers. on the contrary, they did even create quite a few new ones. these factories still have an important role to play, as we will see in the next section, in preserving the flexibility in the network.

Factory networks offer strategic flexibility

Table 3 showed that some of the isolated and several of the receiver factories have disappeared, whereas none of the hosting and only one of the active network players has disappeared. We should add to this that for the one network player which has indeed been closed, the activity did not disappear. Most of its activities (and likewise its personnel) have been transferred to another factory of the company, only fifty kilometers away, where it is organized as a "plant in the plant". So whereas the factory itself has been closed, its activities have remained in the region.

The first conclusion is that the non-network players (isolated factories and receivers) are clearly the source of flexibility in the strategic architecture of the factory network. Nine factories disposed of (Table 3) and 24 created (Table 4) over ten years shows a remarkable flexibility. This is a change in total of 31 factories in eight companies, or about 4 per company over a period of ten years.

The second conclusion is that network players may have a more stable future than the isolated and the receiver factories. This was a conclusion that was hypothesized on the basis of the results of the 1995-1996 study, and has now, after ten years, indeed been confirmed.

The high survival rate among the network players, and the low survival rate among the isolated and receiver factories, give a clear suggestion about how factory managers can safeguard their factory, especially in high labor cost countries. Figure 5

Evolution of network position of factories since 1995-1996 (in % of total)

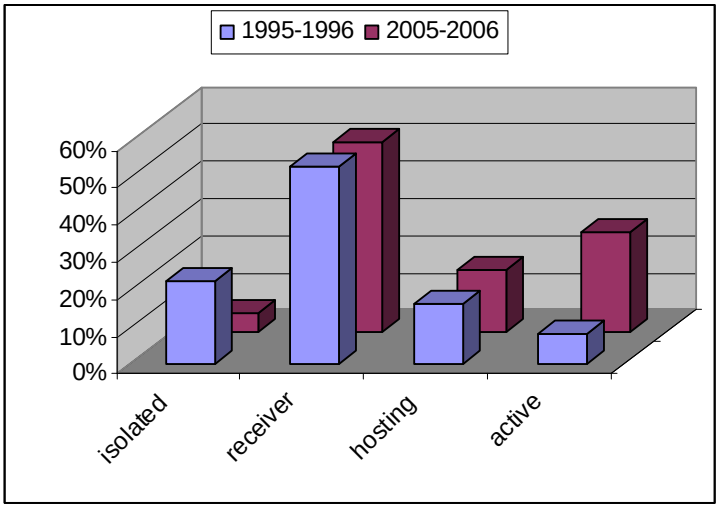

Table 5 shows the development of the factories located in high labor cost countries in Western and Southern Europe only, and this again over the past ten years. Isolated and receiver factories have been combined into a category of the "non-networkers"; hosting and active network players have been combined into a category of the "networkers". With the exception of the factory mentioned earlier, all networkers have survived, while 9 out of 23 non-networkers have disappeared from the network. Interestingly, 7 of the non-networkers have adapted their position over the past ten years, and are now playing a network role. Only the future can show what happens to the other 7 factories that stayed in their non-networking role.

Insert Table 5 About Here

A survival strategy in countries with relatively high wages seems to be to either maintain or to build network relations with the other factories in the network. Innovativeness in itself seems to be insufficient for survival. The willingness to share the innovations with the other players in the network is crucial.

CONCLUSIONS

The outcome of the research

We started by arguing that when it comes to decisions about factory relocation one should take a strategic approach. It would be all too easy to fall in into the trap of shifting factories to emerging countries simply to reap the benefits of low labor cost manufacturing. You may need to relocate factories to low-cost production countries and we all may have to go to China or India for market reasons. But we would like to make the plea to look beyond the cost of the manufacturing network and to develop a truly strategic view of the factory network as a learning network.

In order to do so, we proposed a model that takes into account the flow of knowledge between the factories and within the organization.

Based on a decade of experience with this model, we have learned that it proves to be a useful framework to analyse the dynamics of a factory network, as well as the relationship between location and characteristics of a factory. Our longitudinal research has helped us to confirm and refine some of the assertions we made based on the model.

Not to our surprise, we found that the eight companies in our sample had globalised significantly their manufacturing network over the last ten years. They have closed and opened factories, have expanded their global reach and seem to be doing quite well. In their expansion, the main driver has been the market and to a lesser extent, the development of skills and know-how. Only a minor number of factories were created solely in response to a need for lower production costs. This goes somewhat against popular beliefs, but is in line with what others have suggested.

We observed that multinationals in mature economies tried to preserve their competitiveness by upgrading the capability of the average factory to produce knowledge and by integrating them into the knowledge network. This does however not go completely to the detriment of the flexibility of the network, which is determined by the existence of isolated factories and receiver factories. The flexibility to shape and reshape the architecture of the manufacturing network is highly dependent on the availability of these non-network players.

And what does it mean for the manager?

The role of a factory in a network should be dynamic. But the control over these dynamics should not be left in the hands of the factory managers only, since it would result in an evolution of the individual nodes only. There is a need for a coordinated evolution of the network, i.e. of both its nodes and its flows. For the senior manager sitting in headquarters and orchestrating the manufacturing network, the main message coming from our research is that the design of the manufacturing network is more than a decision of what to produce where and how to organize the logistic flows. It is also about the design and management of the flows of innovation and know-how. One should not leave this to chance; rather, one should also see this as a strategic decision. Facilitating, building and maintaining network relations among factories creates flows of innovation, which may be key to competitiveness. However, this takes time and it requires a willingness to share know-how. Headquarters play an important role in creating the right culture for this openness, and in offering systems to support the network relations.

Yet, at the same time, companies may need some isolated or receiver factories, since they are an “easy” add-on to a network; they offer *strategic flexibility* to networks that are in expansion. This expansion is an important element in the development of international companies, since it puts them on the map of the true global players.

By adding factories to the network in the distant locations, international players can tap into growing markets. Initially for the volume and return they offer; gradually for the know-how that is available in these markets. This probably means that these isolated or receiver factories will gradually evolve into network players.

This brings us to some final comments on offshoring and outsourcing of manufacturing to emerging countries. While strategically important to safeguard and improve the competitiveness of the multinational and thus unavoidable, it is often perceived as unfair at the level of the factory. We are convinced that it is unavoidable for some of the isolated and receiving factories in high labor cost countries to be closed down and moved around. But these factories may protect themselves, not by complaining when it is too late, but rather by anticipating through building network relationships. This takes time, it requires careful strategic planning, and the willingness of headquarters to invest in these network relationships. It requires a high level of management attention, commitment and resources. In particular, personal relationships should be nurtured for knowledge transfers to take place. Network players on the other hand should understand the importance of their role in the network, and should keep on investing in their own innovation capability, as well as in the transfer of their knowledge to the other players in the network. While sharing their knowledge may seem too generous in the short term, it is precisely their reason for existence, and their guarantee for survival in the long term.

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ACKNOWLEDGEMENT

The authors gratefully acknowledge the support of Flanders District of Creativity for this research.

EXHIBIT 1

Potential drivers for establishing/exploiting a factory

Proximity to suppliers
- to benefit from rapid/reliable delivery from suppliers and/or low transport costs
- to be close to low cost suppliers
- to facilitate cooperation with suppliers in product design, planning, etc.
- to have access to source of raw materials

Availability of labor
- to take advantage of low-cost labor
- to take advantage of the availability of workers
- to take advantage of favorable social climate (high productivity, low absenteeism rate, weak unionization, etc.)

Availability of skills and know-how
- to take advantage of highly qualified workers
- to take advantage of skilled engineers
- to take advantage of managerial/organizational skills
- to be close to the source of technological know-how (university, research institute, etc.)

Proximity to market
- to provide rapid/reliable delivery to customers, at low transport costs
- to adapt products to local taste and/or to facilitate co-operation with customers in product design, planning, etc.
- to provide fast service or technical support to customers

Social / Political
- to benefit from tax breaks and/or investment incentives
- to overcome trade barriers
- to benefit from favorable or less stringent environmental regulations
- to reduce the impact of exchange rate fluctuations

Competition
- to be close to major competitors
- to prevent major competitors from establishing a manufacturing facility in the area
- to capture/maintain market share

Energy
- to take advantage of low-cost energy

Other
- to take advantage of highly qualitative environment (air, water, noise, climate)
- to create a high quality of life for employees
- the place of residence of the owner
- to seize a provided opportunity

FIGURE 1

Network role of the factory

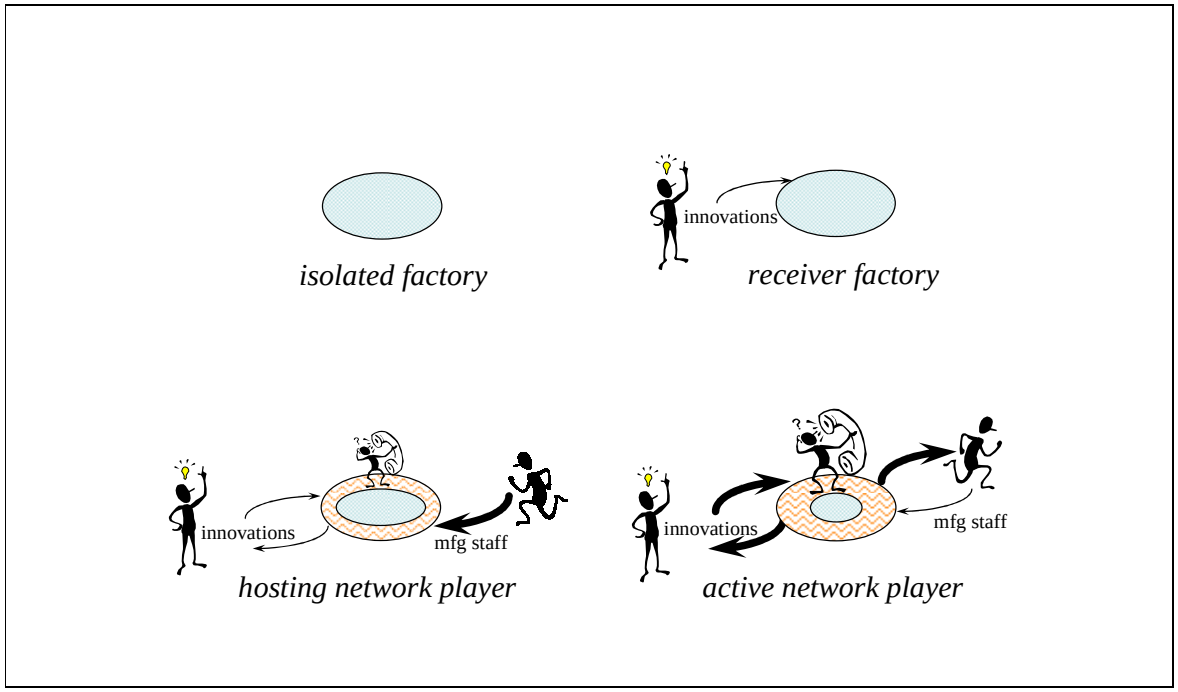

FIGURE 2

Location of factories studied in 1995-1996

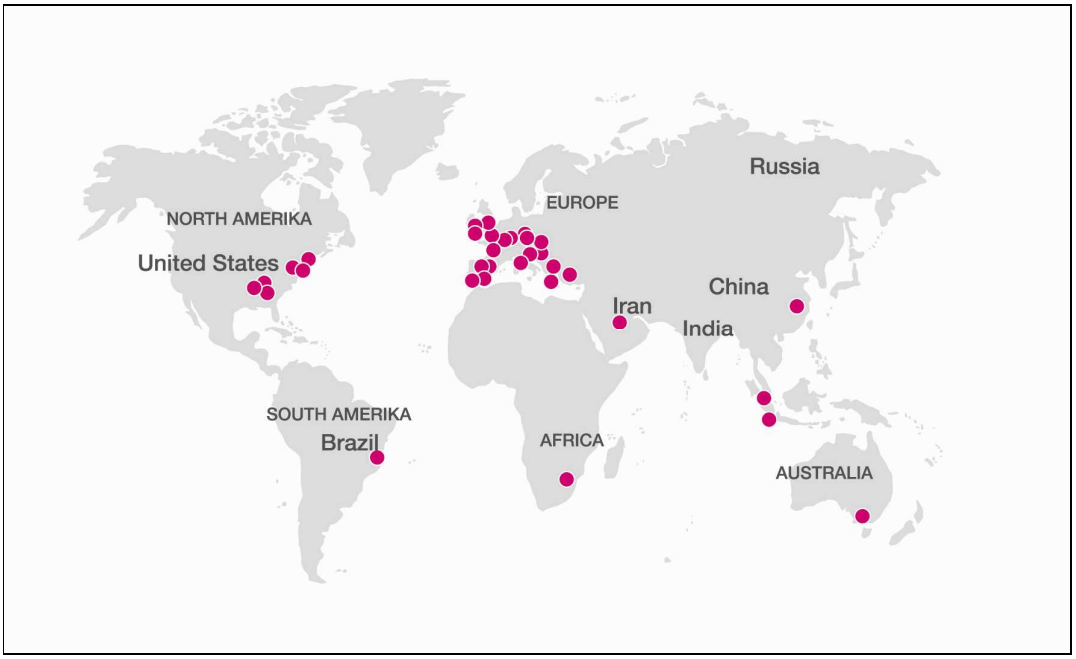

FIGURE 3

Location of factories studied in 2005-2006

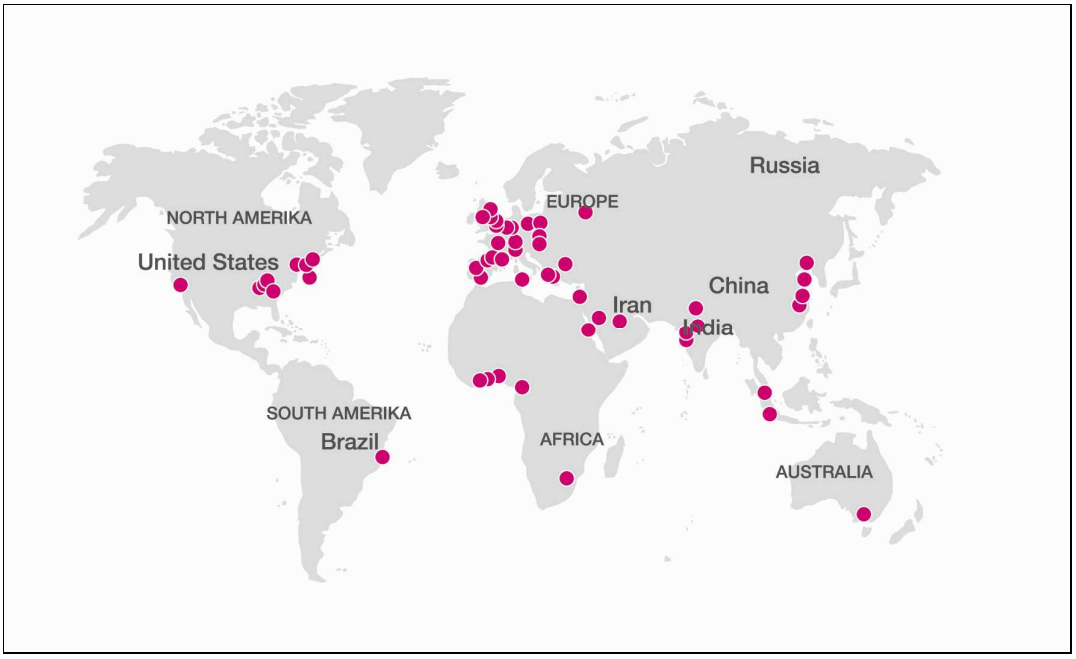

FIGURE 4

Evolution of number of factories since 1995

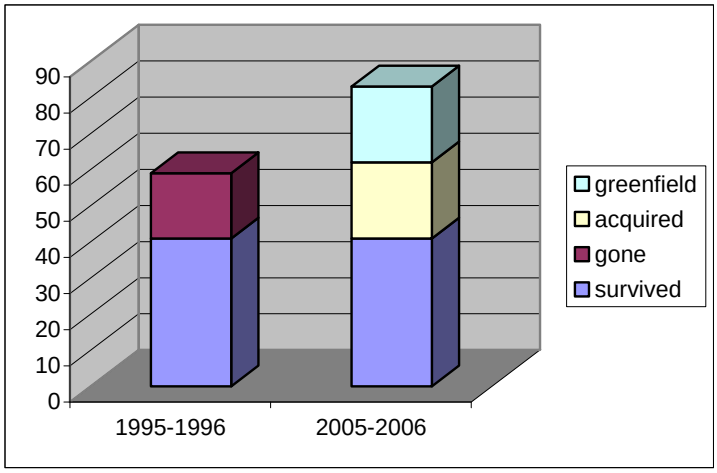

TABLE 1

Evolution of primary location advantages since 1995-1996

primary advantage of the factory in 1995-1996	nr of factories that have disappeared since 1995-1996	nr of factories that have survived	**total nr of factories**
Proximity to suppliers	0	0	**0**
Availability of labor	6	3	**9**
Availability of know-how	0	1	**1**
Availability of skill	1	6	**7**
Proximity to the market	8	30	**38**
Social/political drivers	0	0	**0**
Competition/other drivers	0	0	**0**
No advantage	3	1	**4**
Total nr of factories	**18**	**41**	**59**

TABLE 2

History of primary location advantages in 2005-2006

primary advantage of the factory in 2005-2006	nr of newcomers that have joined since 1995-1996	nr of factories that have survived	**total nr of factories**
Proximity to suppliers	6	1	**7**
Availability of labor	4	4	**8**
Availability of know-how	1	3	**4**
Availability of skill	1	3	**4**
Proximity to the market	28	24	**52**
Social/political drivers	0	2	**2**
Competition/other drivers	2	0	**2**
No advantage	0	3	**3**
Total nr of factories	**42**	**40**[1]	**82**

[1] The number of survivors in table 1 and 2 differs because of missing data

TABLE 3

Evolution of network position of factories since 1995-1996

network position of the factory in 1995-1996	nr of factories that have disappeared since 1995-1996	nr of factories that have survived	**total**
Isolated factory	2	9	**11**
Receiver factory	7	19	**26**
Hosting network player	0	8	**8**
Active network player	1	3	**4**
Total nr of factories	**10**	**39**	**49**[2]

[2] Data on 10 factories out of 59 is missing

TABLE 4

History of network position of factories in 2005-2006

network position of the factory in 2005-2006	nr of newcomers that have joined since 1995-1996	nr of factories that have survived	**total**
Isolated factory	2	2	**4**
Receiver factory	22	18	**40**
Hosting network player	4	9	**13**
Active network player	10	11	**21**
Total nr of factories	**38**	**40**	**78**[3]

[3] Data on 4 factories out of 82 is missing

FIGURE 5

Evolution of network position of factories since 1995-1996 (in % of total)

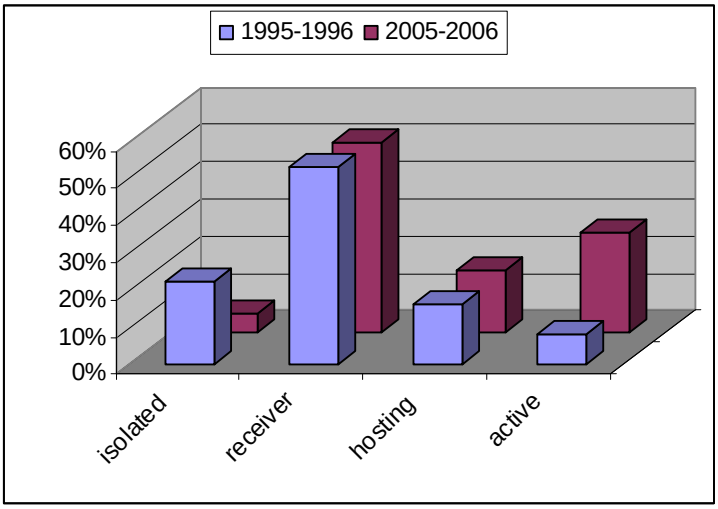

TABLE 5

Development of factories in Western and Southern Europe

	disappered	non-networker in 2005-2006	networker in 2005-2006	**total**
non-networker in 1995-1996	9	7	7	**23**
networker in 1995-1996	1	0	8	**9**