SPECIFICATION MANAGEMENT

1. Introduction

In many industries, manufacturing companies give suppliers increasing responsibilities with regard to the design, development and engineering of components. The reasons lie in the possibilities for manufacturers to better leverage suppliers’ technological capabilities and expertise, thereby aiming to improve product development efficiency and effectiveness. However, despite successes of this approach especially in the automotive and electronics industries, many companies experience substantial difficulties in organizing supplier involvement in product development. We argue that in order to be successful, the involvement of suppliers needs to be embedded in the wider context of bringing a purchasing perspective to the development process. Such a perspective looks at the availability and suitability of external resources (i.e. the knowledge and skills of suppliers) for integration in the development process under conditions of timely availability, and appropriate or optimal costs and quality of the input items (parts, materials etc.) embodying those resources. More specifically, this article examines three critical conditions for successful supplier involvement in product development: identifying specific processes and tasks within purchasing involvement; forming an organization that supports the execution of such tasks; and, finally, staffing the organization with people that have the right purchasing, engineering and social skills.

2. Supplier Involvement in Product Development

Over the past decade or so, the interest in supplier involvement in product development has increased considerably, both within the research and practitioner community\(^1\). This is reflected in the growing popularity of concepts such as ‘Co-makership’, ‘Early Supplier Involvement’, and ‘Design Chain Management’\(^2\).

The interest for the role of suppliers in product development received a big impulse from the studies on differences between Japan on the one hand, and Europe and the US on the other, regarding the management of development projects for new automobiles. These studies showed that Japanese manufacturers were able to bring new automobiles to market at a faster pace, with more innovative features and with less effort in terms of development hours and number of engineers involved. The (partial) explanation seemed to be that in developing new cars, Japanese manufacturers relied more heavily on their suppliers. This implied that using the extra and specialized development potential embedded in the skills, competencies and knowledge of suppliers can make product development more efficient, by increasing the output (a better product, a more innovative product, a faster market introduction) or - but ultimately and - decreasing input (less development costs, less design changes, less engineering hours)\(^3\). Outside the automotive industry, less research has been done on this issue but incidental success stories have been reported\(^4\).

Many of the discussions have focused on the differences between regions, explaining the differences in the context of variances in the extent to which manufacturers in those regions apply cooperative, long-term relationships\(^5\). Several studies have concluded that the involvement of suppliers in product development is especially widespread in Japan, and occurs less frequently in the United States and Europe\(^6\). Following these observations, (automotive) manufacturers outside Japan have recently started to involve their suppliers earlier and more extensively. However, it is too simple to argue that supplier involvement in product development is a...
phenomenon that has only recently started to make an appearance in business. In fact, it has been
around for quite some time, albeit not under the names and sometimes sophisticated programs
currently in use.

This article seeks neither to address the origins of supplier involvement in product development,
nor to identify regional differences and their explanations. Rather, it analyses some of the critical
success factors in managing supplier involvement. In doing so, it draws on original research in a
variety of industries, in trying to avoid a bias towards the ever so popular automotive industry.

Before considering these success factors, this paper first reviews the objectives of our research
and subsequently, the background, benefits and risks of supplier involvement. Following that,
some available research on the actual results of supplier involvement is reviewed, which leads to
a brief analysis of the main problem areas in managing this involvement. Of these areas, we
focus on those problems that are related to the manufacturer and this leads to the identification of
three critical success factors.

Between 1994 and 1998, we have carried out four series of empirical studies in two European
countries, the Netherlands and Sweden, and across a number of different industries. This article
should be seen as a synthesis of our findings from these different case studies.

3. The nature of supplier involvement

Background
The increasing attention for and implementation of supplier involvement in product development
can be attributed to mainly two developments. The first development is the growing importance
of and pressure on innovation and product development as a critical business process in today’s
competition. The second development is the increasing impact suppliers have on manufacturers
with regard to creating and sustaining competitive advantage.

The growing importance of and pressure on product innovation processes is reflected in: the
growing contribution of new products in terms of sales and profits; shorter product life cycles;
and the emphasis on reducing ‘time-to-market’, as observed in many industries.

The increasing (potential) impact suppliers have on manufacturers with regard to creating and
sustaining competitive advantage in general, is mainly the result of a widespread trends towards
‘vertical specialization’, i.e. disintegration. In the first place, this specialization has lead to the
increased outsourcing of support and production tasks, as is reflected in the increase of
purchasing volume's share in companies' production value. Already a decade ago, in a great deal
of industries this share was higher than 50 percent and many sectors nowadays show shares of 60
to 70 percent. In the second place, specialization has also changed the nature of outsourcing, with
firms increasingly buying modules and sub-assemblies rather than single components.

And so, having subcontracted large parts of their production to external suppliers, manufacturers
are increasingly confronted with the fact they have also become dependent on these suppliers
with regard to developing and innovating their products. In short, to create competitive
advantage, companies need product innovations; and to realize potential innovations, and to
realize them quickly and efficiently, they need to co-operate with suppliers.

It is, however, fair to note that it is not only the actual impact of suppliers on manufacturer
performance has increased. It is also firms’ awareness of this impact that has increased. Related
to this, the purchasing or sourcing function of many firms has successively acquired more tasks
and powers. From having been a mainly administrative function earlier on, rooted in the financial
and stock-handling operations in the firm, it has more and more become a commercial and
strategic function. Purchasing can nowadays often be described as 'managing the external resources of the firm'.

**Benefits**

Table 1 contains an overview of the possible benefits of supplier involvement, as suggested by existing literature. What becomes clear from this overview, is that we can make a general distinction between long-term and short-term benefits. Short-term benefits are related to the specific development project the supplier is involved in. Primarily, short-term benefits of supplier involvement in product development can be attributed to two main areas: development efficiency and effectiveness. In terms of efficiency, supplier involvement can lead to the reduction of development costs and the reduction of development lead-time. This is mainly achieved by preventing, reducing or introducing design changes earlier by means of early and intensive communication with the supplier ('first time right' development). It is also realized by separating development tasks, and developing various components or modules in parallel. This helps to solve capacity bottlenecks in the manufacturer’s engineering department. Finally, when for each phase in a development project, design/development/engineering responsibility is given to the most competent company of the two - the supplier or the manufacturer - efficiency is also promoted.

In terms of effectiveness, supplier involvement may lead to the reduction of product cost and the increase of product value. This can be achieved by mobilizing and leveraging supplier expertise regarding Design for Manufacturing (DFM), the quality and reliability of component designs, alternative materials and possibilities for component standardization.

Apart from improving development project performance in terms of effectiveness and efficiency, manufacturers may have an interest in collaborating with suppliers in product development to achieve long-term benefits. These long-term objectives include getting (permanent) access to the technological knowledge of suppliers. In the long run, manufacturers may even have an interest in influencing supplier decisions with regard to the kind of technologies to invest in, in order to provide the best conditions for future technological collaboration. These kind of long-term alignment efforts are visible in the so-called ‘technology roadmaps’ that companies like Ericsson and AT&T draw up together with their suppliers, which serve to identify technological trends for both parties and to provide a basis for discussing future investments. Compared to short-term collaboration, long-term collaboration is much more focused on supporting the development of underlying technologies and capabilities than on designing a specific new product. In essence, this difference could be described as the long-term creation of technological resources vs. the short-term exploitation of resources. Manufacturers and suppliers, in the long run, may even (decide to) develop new joint capabilities, as in the case of telecommunication equipment manufacturers and Internet technology providers developing Internet Protocol (mobile) telecommunication applications.

Research into the actual results of supplier involvement has been limited, however, to the short-term benefits of supplier involvement: reduction in development lead-time, development and product costs, and improvement in product quality. Although all three elements - time, cost, quality - are widely cited as the key benefits, there are indications that their relative importance varies. We will discuss some of this research in more detail in a later section. At this point, it is important to note that supplier involvement does not only have potential benefits; there are also some risks involved.
Table 1: Benefits of supplier involvement

<table>
<thead>
<tr>
<th>Authors</th>
<th>Objectives mentioned</th>
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<tbody>
<tr>
<td>Clark (1989: 1260)</td>
<td>lead time reduction&lt;br&gt;development man-hours reduction&lt;br&gt;more unique parts, better product performance</td>
</tr>
<tr>
<td>Birou and Fawcett (1993: 5)</td>
<td>better resource utilization&lt;br&gt;development and sharing of technological expertise&lt;br&gt;network effectiveness</td>
</tr>
<tr>
<td>Mendez and Pearson (1994: 7)</td>
<td>efficient manufacturability&lt;br&gt;minimization design-to-market cycle time</td>
</tr>
<tr>
<td>Bonaccorsi and Lipparini (1994: 136)</td>
<td>reduction development costs&lt;br&gt;higher product quality with fewer defects&lt;br&gt;reduced time to market&lt;br&gt;supplier-originated innovations</td>
</tr>
<tr>
<td>Zirger and Hartley (1996: 145-146)</td>
<td>time savings&lt;br&gt;reduction part production problems&lt;br&gt;easier communication&lt;br&gt;early problem identification</td>
</tr>
<tr>
<td>Dobler and Burt (1996: 150,158)</td>
<td>reduction of start-up problems&lt;br&gt;prevention of costly delays&lt;br&gt;reduction of material costs&lt;br&gt;improvement of product quality</td>
</tr>
<tr>
<td>Ragatz et al. (1997: 191)</td>
<td>reduction concept-to-customer cycle time&lt;br&gt;reduction of costs&lt;br&gt;reduction of quality problems&lt;br&gt;improve overall design effort</td>
</tr>
<tr>
<td>Hartley et al. (1997: 69-70)</td>
<td>reduction development costs&lt;br&gt;improvement of the buyer-supplier relationship&lt;br&gt;long-term mutual benefits</td>
</tr>
<tr>
<td>Bonaccorsi (1997: 3-4)</td>
<td>incremental product innovation&lt;br&gt;radical product innovation&lt;br&gt;reduction in development time&lt;br&gt;access to new technological knowledge</td>
</tr>
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</table>

**Risks**
The main risks usually associated with supplier involvement in product development relate to increased dependency, reduced flexibility and information loss.

**Increased dependency**
Supplier involvement is argued to result in increased dependency of the manufacturer on the supplier for the design, development and/or engineering of components. Especially when these components make a significant contribution to the final product, in terms of price or technology, the manufacturer will be highly dependent on the capabilities of the supplier for the performance and success of its product. The dependency specifically results from the decline in the manufacturer’s expertise and capabilities that usually occurs regarding the design and engineering aspects and the underlying technologies of the component involved. Such a decline may be the result of a conscious decision to outsource part of the internal capabilities, or just the natural consequence of the manufacturer becoming less often involved in operational development activities.
However, increased dependency is not only a risk. It can also be a condition for being able to motivate or demand a supplier to make a commitment in working with the manufacturer. This is reflected in the positive relation between, on the one hand, technological collaboration and, on the other hand, the duration and the financial importance of the manufacturer-supplier relation. Long-term relationships facilitate information exchange, communication and understanding through shared experiences, and in that way reduce the costs and efforts involved in collaborating. Long-term relationships also decrease the uncertainty regarding the returns on investments in the collaboration, among other because counterparts will choose 'voice' rather than 'exit' as a response to problems or failures. Additionally, there is a positive relation between the financial importance of a supplier relation and the extent of technological collaboration because a large volume provides bigger leverage for any positive results that may be achieved; for example, a reduction in unit costs. In the second place, a large transaction volume enables both the manufacturer and supplier to spread the costs incurred in the collaboration across a greater volume, which reduces the possible threshold for entering such collaboration. Obviously, the causality does not run only one-way; (successful) technological collaboration also may lead the manufacturer and supplier to do more business with each other.

**Reduced flexibility**

The second risk, decreased flexibility, is closely related to the aspect of dependency. It is mainly the effect of the commitment to and possible selection of a supplier starting at an early stage in a development project. By working closely and up-front with specific suppliers, manufacturers may forego alternative technological solutions developed by competing suppliers. The search for better solutions may be limited by the need to exploit and adapt to the existing supplier's capabilities and investments. For example, at the outset of a particular development project it may not be totally clear which is the best technology for a specific component. If in that case a supplier is selected with competencies in only one specific area, the manufacturer is likely to be more or less led or even 'locked' into this technological option while at some point another option would appear preferable. Part of this risk is the possibility that suppliers may develop a component that can only be produced by themselves, for example because of very specific forms or materials. The adaptations made in the overall design of the final product to accommodate the special component may make it more difficult to switch to another supplier for future models.

Usually, in the discussion on the risks of dependence and decreased flexibility, the underlying assumption is that supplier involvement is associated with single sourcing. This, however, need not be the case. Supplier involvement may mean that one specific supplier is selected but also that just a limited number of preferred suppliers is involved. In the latter form, (final) supplier selection does not necessarily take place in an early phase of the development process. In the automotive industry, for example, it is common practice to involve two or three suppliers in the form of a 'Design Contest'. The supplier with, for example, the best technological solution or a price that is closest to the original 'target cost' set by the manufacturer, wins the contract to produce and deliver the product. In some cases, the other suppliers become, for instance, secondary or back-up suppliers or preferred partners for a following car model.

Since the involvement of suppliers demands resources and time, the manufacturer has to weigh the benefits and costs of involving several suppliers for the development of the same component. The risk of decreased flexibility is particularly relevant in projects with a high degree of innovation, in which the required supplier components and capabilities are less predictable. Some argue that for less predictable projects, manufacturers looking for ways to speed up product development may prefer last-minute supplier selection or buying standard
components in order to maintain design flexibility. Moreover, it remains debatable whether this risk of reduced flexibility is specific for the involvement of suppliers; in the case of in-house development, the capabilities and preferences of the own designers and engineers also lead the manufacturer in specific directions, possibly precluding other more useful or profitable solutions.

Information loss

The third risk, loss of information, arises from the (early) disclosure of technical details regarding the new product or from the disclosure of technological knowledge of the manufacturer in general. Joint product development always entails some exchange of technical information or knowledge. Especially the spread of information on new products via suppliers, for example to competitors of the manufacturer, is a sensitive issue. In some cases, suppliers may have restricted areas at their premises where development work is carried out for one specific manufacturer.

The risk of spread of critical information can typically be countered by safeguards such as contracts and trust. Additionally, suppliers may get away with such opportunistic behavior only once or twice before their reputation is damaged, especially in industries where ‘everyone knows each other’. A radical way of preventing this risk is by selecting suppliers that do not work for competitors, or demanding that they don't. Such exclusivity arrangements work, however, against the supplier achieving economies of scope and learning by interacting with several customers. This exposure of external suppliers to different manufacturers and the positive effects it has on knowledge and skills is actually one of the arguments why they are involved in product development in the first place. Some researchers have argued that information loss is of less concern than the impact other customers may have on the supplier’s abilities and willingness to collaborate with the manufacturer. A manufacturer may find it very hard to motivate and mobilize a supplier to collaborate in a particular development project when the supplier has different customers asking the same thing at the same time when the manufacturer has no special advantages to offer.

Summarizing, apart from potential benefits in terms of cost and development lead-time reductions, quality improvements and long-term access to supplier knowledge, supplier involvement carries the risks of increased dependence, reduced flexibility and spread of critical information and knowledge. The following section considers the difficulties of implementing and managing supplier involvement in practice, by looking at some research that points to possible negative results of this involvement and by identifying the main problem areas.

The difficulties of managing supplier involvement successfully

Interestingly, two recent studies present evidence, contrary to the expectations, that supplier involvement in product development is not always beneficial. A survey of 79 small to medium-sized companies in a range of assembly industries found that early supplier involvement and a greater responsibility of the supplier for the development of its component do not lead to decreased costs or higher quality of the final product. Additionally, early and extensive supplier involvement does not lead to a significant reduction in development lead-time. Another cross-case analysis of 83 development projects in the automotive, electronics, defense and medical equipment industries found that the influence of supplier involvement on the success of product development is negative. Supplier involvement results in higher product and development costs, and does not achieve better but sometimes even worse product performance and often longer development time. Interestingly, the latter study makes a distinction between quantitative and qualitative aspects of supplier involvement. Quantitative aspects encompass the man-hours invested by the supplier, investments in knowledge and equipment and the number of meetings
attended. Qualitative aspects cover the supplier’s attitude to collaboration and its ability to communicate. Even greater supplier involvement in qualitative terms, however, has a predominantly negative influence on the results of product development projects\(^{13}\).

The findings of these studies, in our opinion, do not imply that supplier involvement in product development is an inappropriate strategy. There are various plausible explanations for these findings in terms of barriers or problem areas that exist. The problems can generally be attributed to one of three sources: the relation between the manufacturer and the supplier, the supplier, and finally the manufacturer itself. This distinction into problems related to the manufacturer, the supplier or the relation should not be seen a very strict one, since most problems are closely related to each other. The current section considers each of these problem sources in more detail, partly based on previous research and partly on our own research.

**The relation as a source of problems**

Firstly, there may be problems that can not be attributed only to the manufacturer or the supplier, but which are primarily connected to the relationship between the two. Problems like a lack of communication and trust may lead to unclear agreements and diverging expectations, which hinder the collaboration’s effectiveness and efficiency. Significant problems arise when the manufacturer fails to communicate clearly to suppliers what it expects from them, especially in terms of development responsibility for the products they produce. This leads to suppliers forming inaccurate assumptions as to what this responsibility may be, possibly even basing strategies and investments on those incorrect assumptions. The lack of clear project plans and work-packages and the absence of agreements regarding the basic principles of the collaboration leave room for diverging interpretations. More practical communication problems may arise, for example, when the manufacturer and supplier have incompatible CAD systems or use different languages in technical drawings, or have totally different ways of formulating and interpreting technical information.

A lack of trust between the two parties may also hinder collaboration, as both parties will see large potential risks. Because of that, it may be especially difficult to collaborate with new suppliers, which may be necessary, for example, when the manufacturer needs a totally new component.

**The supplier as a source of problems**

Suppliers themselves can pose different problems. In the first place, they may not be sufficiently capable of product development collaboration. One of the main determinants of (successful) supplier involvement is the level of the supplier’s in-house technical capabilities\(^{14}\). However, manufacturers may end up selecting suppliers with little or limited experience in joint product development, for example due to supplier selection criteria only focusing on price. Weighting technological and innovative capabilities more heavily in supplier selection could improve the results of supplier involvement. Obviously, manufacturers will try to select for involvement those suppliers that do have sufficient knowledge and skills, but this may not always be possible. In many countries and industries, increased supplier involvement in product development is a relatively new trend and suppliers may not have had the opportunity to align themselves with the new demands placed on them. It is interesting to note that those manufacturers that usually have been heralded for their extensive collaboration with suppliers in product development provide their suppliers with substantial support in these areas.

In the second place, suppliers may not be able or willing to commit the necessary time, labor and capital. This can be due to the supplier having other customers that demand a high commitment as well, or being uncertain about the potential returns of his investment in the collaboration.
There may also be a limited interest by the supplier in working with the manufacturer, for example because it represents only a minor share of the supplier's total (potential) sales. Limited commitment of the supplier makes the collaboration more difficult and may even have a negative impact on the results of the collaboration by making the supplier less responsive and cooperative.

**The manufacturer as a source of problems**

Problems at the manufacturer itself, related to the involvement of suppliers in product development, exist in a number of areas. In the first place, the manufacturer may not have a clearly defined product development process and strategy. Consequently, there are no clear ideas in what areas, when and how suppliers should be involved. This may lead to involving the wrong suppliers; for example, suppliers with limited innovative capabilities or suppliers of components for which supplier involvement is not necessary or beneficial. Different suppliers need to be involved at different moments, and in different ways: timely supplier involvement is a more appropriate strategy than early supplier involvement.

Problems at the manufacturer may also arise due to resistance at the departments that are most directly involved in and affected by it; purchasing and engineering/product development. The first experiences of DAF Trucks (now part of Paccar) with increasing suppliers’ involvement in product development in the early 1990’s, for example, showed that purchasers were reluctant to select suppliers in an early stage of the development project when they did not have a finished product to base their decision on. Development engineers, on the other hand, may erect barriers for supplier involvement when they feel their work or job is threatened. They may reject the involvement at all, arguing that the communication with suppliers adds too much complexity to their already difficult work, or that suppliers can never achieve the same quality standards they have. During the collaboration, they may impose unrealistic targets and provide insufficient information in order to make the task for suppliers as difficult as possible.

Tensions and disagreements between the two functions may exacerbate the problems. Discussing the relation between the purchasing and the development function, some argue that purchasing’s task is to counterbalance as much as possible the technically oriented company functions such as R&D and product development. The buyer must regard specifications as a variable factor, and be able to challenge their content within his own organization. Underlying this tense relation is a fundamental difference in orientation of the two functions. Table 2 presents an overview of these differences. It is clear that such differences may cause tensions or perhaps even conflicts in product development and the involvement of suppliers in that.

**Table 2 Purchasing and Development orientations**

<table>
<thead>
<tr>
<th>Purchasing orientation</th>
<th>Development orientation</th>
</tr>
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<tbody>
<tr>
<td>• Minimum acceptable margins of quality, safety and performance</td>
<td>• Wider margins of quality, safety and performance</td>
</tr>
<tr>
<td>• Use of adequate materials</td>
<td>• Use of ideal materials</td>
</tr>
<tr>
<td>• Lowest ultimate cost</td>
<td>• Limited concern for cost</td>
</tr>
<tr>
<td>• High regard for availability</td>
<td>• Limited regard for availability</td>
</tr>
<tr>
<td>• Practical and economical parameters, specifications, features and tolerances</td>
<td>• Close or near perfect parameters, specifications, features and tolerances</td>
</tr>
<tr>
<td>• General view of product quality</td>
<td>• Conceptual abstraction of product quality</td>
</tr>
<tr>
<td>• Cost estimation of materials</td>
<td>• Selection of materials</td>
</tr>
<tr>
<td>• Concern for JIT delivery and supplier relationship</td>
<td>• Concern for overall product design</td>
</tr>
</tbody>
</table>

Source: Dowlatshahi (1992: 23)
Of these three possible sources of problems or barriers for achieving successful supplier involvement in product development, both the relation and the supplier have received quite some attention. However, in a survey of purchasing practices in Sweden in 1998, only 16% of the companies indicated that suppliers’ technical competencies were a crucial obstacle to further involvement in product development. Suppliers’ managerial competencies were said to be an important barrier by even fewer companies (14%). The companies, however, more often blamed themselves: 20% of them argued (the lack of) information and guidelines from their side were a big hindrance, while even 25% said the internal collaboration between purchasing and development/engineering was a major roadblock. While the differences are not very large, it does suggest that further attention to the possible barriers within the manufacturer is necessary.

**Conditions for successful supplier involvement**

Based on our research, there seem to be three critical conditions, applying to the manufacturer, for achieving effective and efficient supplier involvement:

1. identifying specific purchasing involvement processes and tasks that need to be carried out;
2. forming an organization that supports the execution of such tasks; and, finally,
3. staffing the organization with people that have the right purchasing, engineering and social skills.

Consider each of these conditions in more detail.

**Condition 1: Identify the necessary purchasing involvement processes and tasks**

The first condition for establishing or improving the involvement of suppliers in developing new products is identifying the kind of managerial activities that need be organized and carried out to support that involvement. We argue that in doing so, it is important to not only focus on the management of supplier involvement in individual development projects. From the broader perspective of the purchasing function, there are many activities in the context of product development that are not directly connected to managing the involvement of specific suppliers in individual development projects. Examples are the participation in the identification of the technological core competencies of the firm and the execution of (supplier) market research with respect to new technologies.

In fact, our research has shown that purchasing involvement in product development can be defined in terms of four different management areas;

- **Development Management:** establishing the general policies and guidelines for supplier involvement in product development, and the technological areas in which to collaborate;
- **Supplier Interface Management:** building an infrastructure or network of suppliers that can contribute to product development processes;
- **Project Management:** managing the involvement of suppliers in specific development projects; and
- **Product Management:** defining the actual product specifications within a development project.

The basic purpose for distinguishing between different management areas is that by doing so, it is possible to define more precisely what purchasing involvement in product development actually consists of. By developing a more explicit delineation of purchasing involvement by breaking it down into different areas, each with specific activities, a framework can be
formulated that summarizes purchasing involvement in terms of a limited number of specific activities or tasks. Such a framework, as depicted in Table 3, may help managers and other business professionals to implement, audit and improve (parts of) their purchasing involvement.

Table 3: Integrated framework of activities

<table>
<thead>
<tr>
<th>Areas</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Management</td>
<td>• Determining which technologies to keep/develop in-house and which ones to outsource to suppliers</td>
</tr>
<tr>
<td></td>
<td>• Formulating policies for the involvement of suppliers</td>
</tr>
<tr>
<td></td>
<td>• Formulating policies for purchasing related activities of internal departments</td>
</tr>
<tr>
<td></td>
<td>• Communicating policies and procedures internally and externally</td>
</tr>
<tr>
<td>Supplier Interface Management</td>
<td>• Monitoring supplier markets for technological developments</td>
</tr>
<tr>
<td></td>
<td>• Pre-selecting suppliers for product development collaboration</td>
</tr>
<tr>
<td></td>
<td>• Motivating suppliers to build up/maintain specific knowledge or develop certain products</td>
</tr>
<tr>
<td></td>
<td>• Exploiting the technological capabilities of suppliers</td>
</tr>
<tr>
<td></td>
<td>• Evaluating suppliers’ development performance</td>
</tr>
<tr>
<td>Project Management</td>
<td>Planning:</td>
</tr>
<tr>
<td></td>
<td>• Determining specific Develop-or-Buy solutions</td>
</tr>
<tr>
<td></td>
<td>• Selecting suppliers for involvement in the development project</td>
</tr>
<tr>
<td></td>
<td>• Determining the extent (‘workload’) of supplier involvement</td>
</tr>
<tr>
<td></td>
<td>• Determining the moment of supplier involvement</td>
</tr>
<tr>
<td></td>
<td>Execution:</td>
</tr>
<tr>
<td></td>
<td>• Coordinating development activities between suppliers and manufacturer</td>
</tr>
<tr>
<td></td>
<td>• Coordinating development activities between different first tier suppliers</td>
</tr>
<tr>
<td></td>
<td>• Coordinating development activities between first tier suppliers and second tier suppliers</td>
</tr>
<tr>
<td></td>
<td>• Ordering and chasing proto-types</td>
</tr>
<tr>
<td>Product Management</td>
<td>Extending activities:</td>
</tr>
<tr>
<td></td>
<td>• Providing information on new products and technologies being developed or already available in supplier markets</td>
</tr>
<tr>
<td></td>
<td>• Suggesting alternative suppliers, products and technologies that can result in a higher quality of the final product</td>
</tr>
<tr>
<td></td>
<td>Restrictive activities:</td>
</tr>
<tr>
<td></td>
<td>• Evaluating product designs in terms of part availability, manufacturability, lead-time, quality, and costs</td>
</tr>
<tr>
<td></td>
<td>• Promoting standardization and simplification of designs and parts</td>
</tr>
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</table>

The argument for making specifically this distinction is twofold, based on the characteristics of purchasing involvement activities encountered in practice. First, different activities have different time-horizons. Project and Product Management comprise activities that are related to specific individual development projects; they are often recurrent, but within the context of a project. Development Management and Supplier Interface Management, however, involve the more long-term, permanent tasks of establishing principles and guidelines for supplier involvement and building a supplier base; activities that need be carried out also (and often especially) in between projects. The second argument for making the distinction between different areas is that in practice, purchasing involvement activities are performed at different (hierarchical) levels in the organization:

- Buyers and development engineers may discuss the design of a new component, or jointly track the progress a supplier is making in engineering a specific part;
• Purchasing managers and R&D-specialists may periodically meet with key suppliers to review ongoing business and discuss potential new projects;
• Purchasing directors may develop guidelines for their department’s role in product development projects; and
• General management may take decisions to outsource future research and development in a specific technological area to suppliers.

For these two reasons then, we suggest it is useful to differentiate between four management areas when considering purchasing involvement in product development. The four management areas are complementary to each other, although in practice there may be some overlap. For example, Project Management is closely related to the more permanent Supplier Interface Management regarding supplier relationships, since development projects are ‘episodes’ in those relationships. Similarly, the division of responsibilities between the suppliers and the manufacturer regarding the development and maintenance of technological knowledge and competencies (Development Management) relies to a large extent on the opportunities offered by the individual supplier relationships (Supplier Interface Management). In many respects, Supplier Interface Management is the critical link between the long-term activities in the area of Development Management and the more short-term oriented activities in Project and Product Management.

In our research, we have found that very few companies actually try to manage these four areas. In a typical situation, Project and Product Management are carried out to some degree but they are not firmly rooted in more fundamental Supplier Interface Management, which leads to, for example, extensive supplier selection discussions and problems in the early phases of a project. Alternatively, companies do try to set up some form of Supplier Interface Management, but there is no internal consensus in what technological areas the firm needs partner-suppliers and on what terms, since no effort is being made in the area of Development Management. Philips Medical Systems is a typical example of a company suffering from both problems (see Box 1).

**Box 1: Purchasing involvement at a medical equipment producer**

Philips Medical Systems (PMS) is one of the world’s four leading medical equipment producers. It delivers diagnostic image producing and processing equipment, related therapeutic equipment and complementary services to hospitals. It has about 9500 employees. Production is characterized by small series, R&D expenses are moderate and the purchasing ratio is relatively high. Recent cost-reduction efforts at the company have led to increasing discussions on what should be (remain) the core-competencies of the company and what should be outsourced. As a consequence, the involvement of suppliers in product development and the concomitant role of the purchasing function have become an important issue for the company. However, PMS and especially the business unit X-ray Diagnostics (XRD), have significant problems in involving purchasing in product development:

- Development Management is not sufficiently performed; the lack of guidelines for supplier involvement leads to obscurity internally and externally, reducing suppliers’ ability and willingness to collaborate;
- Supplier Interface Management is an area with new demands, since PMS is trying to change its interface with suppliers by giving them more complex products to develop and to manufacture, requiring more emphasis on market research;
- Project Management seems the most problematic area, with many activities being performed on the basis of personal insights and ad-hoc considerations; and
Product Management tasks are hardly carried out; engineers see these as the responsibility of purchasers, but the latter are involved too late in the development project and have too little market insight.

It is important, at this point, to emphasize that the purchasing involvement activities in product development are not the sole domain of the purchasing department. These are activities that, in our opinion, form part of the functional responsibility of purchasing; they are part of the purchasing process. Given the fact that they actually lie at the ‘intersection’ of the purchasing and product development function/process, it is only logical that some of the activities will – and can – be performed by development and engineering representatives.

**Condition 2: Developing an organization supporting the execution of the various purchasing involvement tasks**

The second condition for successful supplier enabling factor is an internal organization that supports the execution of the various activities within purchasing involvement in product development. Companies have implemented different organizational mechanisms to deal with supplier involvement in product development. These organizational mechanisms or designs all aim to provide a useful interface between (especially) the technical function (i.e. design, development, and engineering), the purchasing function and the supplier. These organizational designs differ mainly in terms of the project team structure and the organization of the purchasing (sourcing, or procurement) department. The organizational design for a particular company should reflect the specific context it is facing, for example, in terms of the frequency and magnitude of development projects and the complexity of the overall organization. Let us briefly review some of the most popular mechanisms, some of which may be used in combination with each other.

The first, most common and simplest organizational mechanism is the separation between initial and operational purchasing units. This may increase the ability of that department to perform the initial tasks, many of which are related to managing supplier involvement in product development.

When operational and operational tasks are to be performed by the same persons, the often more urgent (which is not the same as important) operational tasks tend to get the most attention. On the other hand, however, a very high degree of complexity may make it more difficult to coordinate various activities within the purchasing department itself.

A second alternative involves appointing engineering liaisons within the purchasing department. These people act as sort of permanent liaison officers between purchasers and development engineers. Usually, they are responsible for exchanging information between the two functions, such as requests for and results of market research projects regarding new technologies.

The third option involves the participation of purchasing representatives in cross-functional development teams, either with a single coordinator for different purchasing issues or participation by a number of purchasing representatives. The participation of the purchasing function may benefit the performance of the activities from our framework. In the first place, participation means that purchasing representatives are likely to be better informed about the project which enables them to better 'tailor' some of their activities to the needs of the project. In the second place, purchasing may be able to influence certain decisions to comply with the general purchasing strategy; for example, selecting a supplier that is already a preferred partner to develop a specific component.
Finally, probably the most radical organizational mechanism to support the integration of the two functions is the permanent integration of development/engineering and purchasing. Some companies have established commodity-teams, in which both purchasers and engineers participate to jointly work on issues such as supplier and part approval. Hollandse Signaalapparaten (part of CSF Thompson) provides a good example (see Box 2).

**Box 2: Teamwork at Hollandse Signaalapparaten**

A company that has gone quite far in integrating its purchasing and development department, not only regarding development projects, but rather on a *permanent* basis is the Dutch manufacturer of military radar systems, Hollandse Signaalapparaten. This company employs so-called Article Specialists; permanent teams that support development project teams in selecting certain suppliers for project involvement etc. The teams consist of one purchaser and one engineer, who are specialized in a specific range of products. The duos provide assistance in areas like develop-or-buy decisions, market research, supplier and part selection. The specialists have to give their permission to development engineers that want to design a new component, by signing a request for the introduction of a purchase item. Based on their experience, technical expertise and market information, the Article Specialists may agree on the specifications and propose the appropriate supplier, or suggest a different design so that available suppliers can meet the specifications. Alternatively, the Specialists may reject the request and refer the engineer to the company’s list of standard purchase parts if they think the costs of designing and producing a new part outweigh the benefits, while an existing component can do the job too.

Hollandse Signaalapparaten has about 20 of these duo's, which report to 'Article Teams' for a specific technological area (f.e. mechanics). These teams, six in total, consist of the responsible group leaders from R&D and purchasing. The teams, in their turn, report to a Steering Group that consists of the R&D manager and the purchasing manager. This joint organization constitutes a permanent integration between the development and the purchasing department.

All of these mechanisms may be supported by the physical co-location of purchasers and development engineers (and supplier representatives). For the complex communication involved in product development to evolve rapidly and effectively, close physical location of development team members is often argued to be of great importance.

Many companies, in our research, seem to realize the importance of a cross-functional interface of some form between the technical and the purchasing function. However, the actual implementation of such an interface is often dependent on how far the overall organization has developed in terms of cross-functional and process thinking. Sometimes, ‘cross-functionalization’ is also being hampered by the efforts of the purchasing department to strengthen its own position, resulting in more internally oriented ‘empire-building’ than outward-looking integration efforts.

**Condition 3: Staffing the organization with people that have the right purchasing, engineering and social skills**

Probably the most critical requirement for successful supplier involvement is adequate human resources. A firm may have a clear view of the processes and activities that need to be managed, it may have a strong organization in terms of a truly cross-functional development team, and it even may have good information systems with regard to supplier and component data. Still, the people - and the quality of those people - working in that organization and with those systems
determine, in the end, to a large extent whether the various purchasing involvement activities are indeed carried out and how well they are being carried out.

Prior research has distinguished a number of personal attributes of purchasers that affect their abilities to participate effectively in the development of new products:

- kind of previous experience;
- kind and level of training/education;
- degree of technical expertise;
- degree of pro-activeness; and
- abilities as perceived by others (credibility).

**Previous experience** that purchasers have had in other functions within the firm, primarily in technical functions such as R&D and Engineering, may enhance not only their technical knowledge but also their understanding of how they can contribute to the product development process. They may have achieved a better understanding of the development and engineering process and of the demands and priorities that engineers put on certain issues, which enables the purchaser to ‘speak the engineer’s language’.

Regarding the **kind and level of education**, research has found that purchasing representatives with an academic education are more intensively involved in product development than those without. These two aspects are closely related to the third aspect: degree of technical expertise. In fact, the first two are argued to contribute to this expertise. Understanding of the technical aspects of the final product and its components may enable the purchaser, for example, to give more informed comments on new technical developments in the supplier market and provide appropriate suggestions regarding alternative (standard) parts.

The fourth aspect concerns the **degree of pro-activeness** of buyers. Pro-activeness refers to the willingness and aggressiveness of purchasers to participate in activities related to product development. Purchasers that are content to focus on routine tasks such as filling out ordering forms will be more reluctant to participate in more uncertain processes such as product development. As we have seen in our case studies, within one and the same company, the pro-activeness of individual buyers often makes the final difference between getting involved and not getting involved in development projects.

The final aspect of human resources concerns their overall abilities as perceived by others. No matter how skilled and pro-active purchasers are, if their counterparts in the product development process - primarily, engineers - do not perceive purchasers as being capable of adding value to the process, the involvement of purchasers will be not very effective.

**Box 2: Human resource management at Ericsson**

Between 1994 and 1998, Ericsson’s business area BN - involved in the development and production of (public) exchanges - has undergone major changes in its production structure, following a strong reorientation on its core competencies. Outsourcing efforts have focused mainly at the area of Printed Board Assembly (PBA), involving suppliers like Solectron, SCI Systems and Flextronics (referred to as CEM’s: Contract Electronics Manufacturers). In doing so, BN has drastically reduced its number of suppliers. In 1993, it had some 3000 suppliers, with 130 suppliers accounting for 80 % of the total purchasing spend: now, it has some 100 production suppliers in total. Especially in the product areas PBA, box-build, and Cabinets and Cabling, BN has reduced the supply base through having less suppliers per product and by increasing the level of integration in the products it buys (systems strategy). With the remaining suppliers, BN is striving for increasing collaboration. As an illustration, for first tier suppliers BN has set the following leading principles:
• Time-To-Market (TTM, the time it takes to bring a new product to the market) and Time-To-Customer (TTC, the time it takes to deliver an existing product to a customer) responsibility;
• supplier selection in initial stages of development projects, and intensive design collaboration;
• products single-sourced over lifetime (life of type contracts); and
• standard supplier-Ericsson interfaces for communication.

This transition at Ericsson BN towards an increased collaboration with suppliers in product development has been supported by a strong emphasis on the development of human resources. In three years time, BN has been moving up the value chain quite rapidly. This has meant that from buying mainly raw material, it has increasingly gone to buy electronic components, and subsequently Printed Board Assembly and Box-build solutions. In terms of the skills required from the people being involved in the sourcing of these increasingly complex products, this has lead to a continuous competence gap. It is important that this gap is addressed constantly by means of competence management.

The new director who came to BN Sourcing in 1994 realized the importance of human resource management, and hired a new person to do that job. Rather than having traditional, operational personnel management tasks like recruitment and contract issues, this person was able to devote his time nearly exclusively to competence management issues. Critical factors in the success in Sourcing’s competence management approach have been the support of top management and the continuous involvement of the Human Resources department in this process. Competence development has been a constant item at the management group meeting every second week. In 1997, as a result of all the efforts, BN Sourcing was named Best Practice example with regard to Competence Management within the whole of Ericsson.

To these five aspects of human resources, we would like to add a sixth: social skills. Although not specifically for purchasing involvement in product development, aspects like communication skills and the ability to collaborate in team settings are equally important as the tangible aspects of education and experience.

Obviously, we have now focused on the human resources of purchasing representatives but much of this applies also to engineers. As stated earlier, it is not so important which department is performing the purchasing involvement activities, as long as they are executed by people with the right knowledge and skills. Engineers may, for example, be working at a purchasing department to increase their understanding of the purchasing process, or be sent on a course program to give them some basic purchasing skills.

It seems that those companies that really make an effort to improve purchasing and supplier involvement in product development by means of developing plans of what to specifically (condition 1) and by setting up organizational mechanisms to support cross-functional collaboration (condition 2) also realize that this has to be complemented with efforts in the area of human resource management. Many firms are hiring new purchasers and purchasing managers with engineering backgrounds, either internally or from outside. However, less attention seems to be paid to what other people in the organization think of purchasers and how this can be changed, which often proved to be equally important as the actual capabilities of the purchasers. Few purchasing organizations make structural efforts to ‘market’ their capabilities, something that can be done for example through joint (‘off-line’) discussion and training sessions with engineers.
4. Conclusions

Supplier involvement in product development holds great potential, both in the short and long run, but few companies seem to be able to realize these benefits. There are several possible explanations for this. Manufacturers may choose half-hearted approaches because they perceive substantial risks in supplier involvement in the form of increased dependency, reduced flexibility and information loss. An even larger part of the unfulfilled potential is due to common problems such as lack of communication and trust, insufficient supplier abilities and willingness, and internal resistance at the manufacturer. This article has pointed to three conditions or steps for dealing with some of these problems as they primarily occur at the manufacturer:

- First of all, the necessary activities and processes with regard to managing supplier involvement in product development need to be identified. We have argued, in fact, that supplier involvement needs to be extended to purchasing involvement; bringing an ‘external resource’ perspective to the development process. Successful purchasing involvement in product development consists of a number of closely related activities that are carried out at different levels in the organization, and which have different time-horizons. Integrating and coordinating the activities throughout the organization and synchronizing short run and long run activities is of crucial importance. Arguing that purchasing involvement consists of four different yet closely related areas of activities, however, does not mean that all activities are equally necessary or important for different companies. In other words, there may or may not be particular contextual antecedents or ‘driving’ factors present in a certain situation. Therefore, when identifying the appropriate purchasing involvement activities in a given situation, it is very important to consider the specific context. Based on our cross-sectional case studies, there seem to be at least four major driving factors related to the manufacturing firm that affect the significance of the different management areas: the size and complexity of the organization; the type of production technology employed; the importance of R&D processes; and the dependence on suppliers. Company size specifically seems to drive the need for Development Management, especially the formulation and communication of supplier and purchasing involvement policies. Regarding production type, the distinction between assembly processes and process production signifies a difference in the number and variety of parts incorporated in the final product. Those factors are driving factors in the need for activities in the areas of Project Management and Product Management. The third driving factor, the (financial) importance of R&D expenditure, bears mainly on Development Management, while the fourth and final driving factor, supplier dependence (f.e. measured by purchasing ratio), has an impact on Supplier Interface Management. In short; a large manufacturing firm, with assembly process production, high R&D expenditure and a high purchasing ratio is required to spend a great deal of effort on all four management areas.

- The second condition relates to the organization of the purchasing function, and especially the part that is involved in the tasks and processes described here. This
organization should facilitate the cross-functional collaboration between the purchasing and engineering function. Such cross-functional collaboration may take different forms, from ad-hoc liaison type of collaboration, via temporary team-structures to full-fledged permanent integration. Different situations require different solutions, but all aim to do the same thing: make development into teamwork, and support the effective integration of suppliers in the manufacturer's product development process.

- The third condition for successful supplier involvement in product development involves the availability of adequate human resources. Or, as some researchers have put it:

  “Management directives, policies and procedures supporting early purchasing involvement all help. But it is only when design engineers realize that an early involvement of a professional buyer is a productive asset, and not a nuisance, that early purchasing involvement makes its full contribution”.

In order to support the development of human resources, there are several areas in which possible measures can be taken. In the area of recruitment and training, emphasis may be given to the education and technical experience of potential employees, and their perception of the tasks of purchasing. By means of job or employee rotation, purchasers could be temporarily assigned to the development department, which would create a better mutual understanding of the links between engineering and purchasing. Finally, communication with other departments about the possible support purchasing can (and should) offer could create a more positive perception of the actual capabilities of purchasers.

Involving suppliers in product development can result in major benefits in terms of money and time. But, it requires a great deal of thinking and effort. Primarily, it presupposes active management on behalf of the manufacturer, both in the short term (project management) and in the long term (technology management, networking), supported by adequate organizational and human resources.
Directions for further study

Books:
Robert M. Monczka (Editor), Robert B. Handfield, Thomas V. Scannell, Gary L. Ragatz, David J. Frayer (2000), New Product Development: Strategies for Supplier Integration, ??.


Academic papers:


Practice articles:


Notes


There are various indications of supplier-manufacturer collaboration in product development not being only a recent phenomenon. In the mid 1980's, a study of over 120 small and medium-sized manufacturing companies in Sweden found that some 75% of the firms were co-operating with one or several of their suppliers in product development: H. Håkansson, *Corporate Technological Behaviour: co-operation and networks* (London: Routledge 1989), p. 77. And already in 1958, Toyota made use of suppliers’ resident engineers, see: Nishiguchi, op. cit..


See Håkansson, op. cit., (pp. 75-82, 108-119).

A.O. Hirschman, *Exit, Voice and Loyalty – Responses to Decline in Firms, Organizations and States* (Cambridge, MA: Harvard University Press 1970); In D.M. McCutcheon, R.A. Grant and J. Hartley, “Determinants of new product designers’ satisfaction with suppliers’ contributions”, *Journal of Engineering and Technology Management*, 14 (1997): 273-290, findings suggest that design engineers are more prepared to use a specific supplier in future joint projects when the suppliers has already been used for over longer period; a long-term relationship may lead the manufacturer to downplay poor supplier performance in a specific project.


Wasti and Liker op.cit., found that in-house technical capabilities have a significant positive influence on the level of supplier involvement, especially on the influence the supplier has on design decisions. 

The activities of both areas are carried out during a specific development project, and have therefore a more limited time frame than the activities within Supplier Interface Management and Development Management. The difference is that Project Management entails all those activities aimed at managing the actual development project(s), whereas Product Management relates to all activities that contribute to the actual design and the determining of the specifications of the
product to be developed. It encompasses decisions on how to structure the design, what technical norms and standards to use, what materials to consider etc.

