A Supply Chain Perspective on Initiatives in the Casting Industry

Chetan Soman, M.Tech. Student, IE & OR
Narayan Rangaraj, Assistant Professor, IE & OR
B.Ravi, Assistant Professor, Mechanical Engineering

Indian Institute of Technology, Bombay - 400 076
Tel: (+91) 22-576-7510  Fax: (+91) 22-578-3480

Abstract

With engineering companies opting for external sourcing of sub-assemblies to enable focusing on core activities and reducing inventory costs (lean manufacturing), casting suppliers have to gear up for new opportunities as well as challenges. This is particularly true in the case of automobile component manufacturers, where there is tremendous pressure from automobile assemblers looking for assured quality and reliable delivery of cast components from foundries. As a result, traditional one-time relationships between the customer and supplier are giving way to long term strategic partnerships. This paper presents a study of this shift taking place in the wake of liberalization and competitive pressures in India, focusing on the casting supply chain in the automobile industry. The study is meant to create an awareness of the potential benefits and concerns in partnerships for sourcing of cast components and is expected to be of value to both assemblers and suppliers in this sector.

Keywords: Casting, Partnerships, Strategic Sourcing, Supply Chain, Supplier Evaluation

1 Introduction

In the wake of liberalization automobile assemblers, more than ever before, face incredible pressures to reduce costs. Raw materials, components and other supplies account for 60 to 70 percent of the cost of a vehicle produced and thus provide the single largest potential for reducing overall costs. More importantly, other competitive priorities such as quality, delivery and new product introduction are also significantly influenced by the actions of suppliers and how the interface between suppliers and the automobile assembler are handled.

The automobile is a very complex engineering product with more than 10000 components. A number of these components are produced by casting and form a major outsourced group. This is in spite of the fact that in India, many auto giants like TELCO, Ashok Leyland and Mahindra & Mahindra have their own foundries. Outsourcing is rapidly becoming a viable option for a number of reasons to do with costs, core competencies, managerial complexity of organisations and activity specialisation. But outsourcing means that increasing demands on final product performance, variety, and quality have to be now viewed afresh. The ripple effects of these are felt in all directions of the automobile supply chain. The casting supply chain is no exception.
A typical casting supply chain in this context is shown in figure 1. Successive stages in this chain are often performed by different firms. Cast components range from extremely complex shapes such as engine blocks to simple castings like flywheels. Typically, a cast component requires two or more stages of machining and is then assembled with a number of other components to form a sub-assembly.

Our study was carried out to discover and understand various strategies for managing such casting supply chains. There are a number of technical and managerial aspects in the planning and operation of such supply chains. In the present study, we survey some broad shifts in the way different players in the supply chain perceive their roles, as well as the technical aspects of quality, design and logistics which along with costs, determine the overall competitive position of the end product of the physical supply chain. One view of supply chain interactions is provided in figure 2, which emphasizes flows of different kinds between the firms involved.

In the following section, we briefly summarize major changes in buyer supplier relationships in general. Sections 3 and 4 are devoted to analyzing the casting supply chain, with special reference to the auto industry. In the last part of our paper, we develop the theme of strategic sourcing and provide useful insights into evolution of partnerships.

2 Shifts in Buyer-Seller Relationships

With shifting competitive priorities, there have been corresponding changes in the way customers and suppliers in supply chains deal with each other. An era of price based competition led to vendor relationships dominated by cost considerations. We refer to such a relationship as a traditional relationship.

The traditional relationship could be characterized by arms-length, market based, short-term interactions between independent business entities [1]. The buyer and the seller tended to view each other as adversaries competing for a larger share of the resources rather than co-operating members of an overall supply chain. This adversarial emphasis required that firms establish bargaining power over their counterparts, and this power relationship determined the relative distribution of wealth between them. This relationship also tended to emphasize short-term product/project based projections. In this type of situation, buyers tend to emphasize the current purchase price and quality of products from the suppliers rather than the long term total costs and quality capability. The availability of alternative sources of supply was considered desirable and was a critical element for ensuring an efficient marketplace. Consequently, a multiple sourcing policy is frequently favored and purchasing tended to put its efforts into creating credible alternative sources of supply.

As non-price factors began to take the position of order winning competitive factors, manufacturing practices began to respond to the demands of higher quality, quicker delivery and frequent new product introduction. There were corresponding shifts in vendor management. For example, the introduction of Just-In-Time (JIT) / lean manufacturing required matching developments in purchasing philosophy. The newly adopted concept of JIT purchasing is based largely on a collaborative buyer-supplier relationship rather than on an independent adversarial relationship. There is less emphasis on the power relationship between the buyer and supplier,
since the new relationship calls for sharing of long-term benefits for both buyer and seller. This also means that emphasis has shifted to the long-term capability of a reliable supplier and away from the short-term capacity of multiple sources [2,3]. Table 1 summarizes these shifts in buyer-seller relationship.

In the sections to follow we report our study of casting supply chains.

3 Supply Chain Initiatives

The changing style of supplier-buyer relationships has resulted in a number of different initiatives by supply chain players. These initiatives are broadly aimed at achieving the competitive objectives of the supply chain as a whole. In each case, we report or comment on specific examples of initiatives taken by automobile assemblers and their foundry suppliers.

3.1 Equity in Supplier Company

Two extreme options available to large assemblers are to (i) integrate their suppliers into a single, large bureaucracy or (ii) have a marketplace relationship with these completely independent companies. A good intermediate option is to retain a fraction of equity and develop new relationships with some of their suppliers who had been completely independent. We have seen auto manufacturers who hold significant equity in firms making many diesel engine and automobile components like manifolds and gearbox covers.

It has been reported that Maruti Udyog Limited (MUL) has taken up equity stakes in its vendors [4]. In MUL's case, three reasons for equity investment in vendors are reported: first, where a single vendor is desirable because the investment is quite large for a single supplier firm but volumes are not enough to justify two vendors from the buyer’s point of view; second, where the items are bulky and need to be located nearby and, third, where foreign companies are ready to share technology with the supplier on the condition that MUL has a stake in it. The implication of equity investments in vendors is that the buyer will have a say, or strongly influence major actions of the vendor, such as capacity expansion and technology selection and development.

3.2 Financial Support

Another form of financial involvement and control of supplier operations is through financial assistance (soft loans, good credit terms) or marketing support (assured orders in certain volumes over some time), so that the supplier can invest suitably. Leading automobile manufacturers have been instrumental in the setting up of dedicated lines for their specific product needs, in foundries.

3.3 Supplier Programs

Supplier programs are being used as a powerful communication tool by automobile assemblers. To begin with, these programs keep the suppliers informed on topics of mutual interest. More importantly, they provide the assembler an opportunity to communicate directly with personnel of the supplier firm and achieve some commonality in product philosophy, marketing goals and good manufacturing practice.
For example, Mahindra & Mahindra arranges ‘Value Engineering’ workshops where suppliers visit the assembler's plant and talk to those operators and supervisors who are their direct customers. Initially, these programs are cost reduction efforts aimed at breaking down the costs of each stage of manufacture, identifying each factor that could lower the cost of each part.

3.4 Vertical Integration

Quality at source and logistical efficiency are two drivers for integration of entities in supply chains. For example, casting defects like blowholes and porosity are detected after rough machining only. From a quality perspective, it is beneficial to have this operation as close to the foundry operation as possible. Since this requires general purpose machines, foundries have found it feasible to do forward integration and add rough machining to their activities.

We have even seen examples where backward integration of foundry technology and casting operations is taken up by traditional machine shops. This is much rarer, but the overall supply chain benefits of assured quality supply of castings has made it attractive enough for machining suppliers to invest in casting technology.

Finally, we observe that suppliers are being strongly encouraged to supply completed subassemblies or kits containing components for an entire subassembly to avoid the logistical complexities of co-ordinating different components for different assemblies. Casting manufacturers who want to be part of this supply culture have to procure and supply additional components to meet this demand.

4 The Technical Interface

The managerial initiatives discussed in the previous section need to be accompanied by changes in the technical interface between supplier and buyer. With respect to the casting industry as part of the automobile supply chain, we discuss, in turn, the crucial competitive considerations of quality, logistics and design. Cost control is not specifically discussed for two reasons. One, it represents the major thrust of earlier purchasing philosophies of assemblers and most of the good practices in that area are discussed in the literature on materials management and purchasing. Secondly, apart from direct processing costs, it is now well appreciated that poor quality, inventory (as a result of poor logistical decisions), and inefficient design are major (but not as well understood) factors contributing to cost (Figure 3).

4.1 Quality

Responsibility for Quality: Traditionally automobile assemblers express their quality targets as an acceptable percentage of bad parts. When they find fewer bad parts than the acceptable level, these are tossed in the waste-bin or sent back for rework and a price deduction. Only when the number of defective parts goes above the acceptable level, the assemblers do something drastic - send the whole shipment back and/or refuse payment. It is strictly the supplier's responsibility to find the problem and correct it. The assembler's intervention is not allowed by the suppliers, because they will lose valuable data on their operations and cost-information, which assemblers may use to bargain down the prices for follow-on contracts. This is common practice even today,
but in future: the days of single supplier and partnerships, this will be somewhat modified. Defect prevention will still mainly be the responsibility of the supplier, but in the case of complex quality problems, the buyer will also have to help out its supplier from the crisis.

Quality Systems: Quality system certification is seen by suppliers as one of the prerequisites for becoming a supply chain partner. All the automobile companies are planning to increase the number of ‘self certified’ vendors which will be essentially ‘ship-to-use’ and if possible ‘ship-to-WIP’ suppliers. This has resulted in most suppliers going in for formal quality systems which allow them to work in such a manner. This also means that assemblers will be working without the traditional safety nets of incoming parts’ inspection. Therefore, both suppliers and customers will have to take proactive steps for defect prevention and to assure timely delivery of quality products.

An automobile industry specific standard QS 9000 is also emerging as a required quality standard. QS 9000 has been developed by the three American auto giants: General Motors, Ford and Chrysler. The goal of QS 9000 is the development of an ISO 9000:1994 based system that provides for continuous improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain, and calls for the use of various methodologies like Value Analysis, Design of Experiments and Cost of Quality. Some companies have even set dates after which they will source parts and materials only from QS-9000 certified companies. A few leading casting manufacturers in the country have already successfully achieved this certification.

Warranties: Warranties is yet another area which every player in the supplier chain should be aware of. Automobile manufacturers compete in the market where the standards of fuel economy, emissions, engine durability and safety are becoming increasingly rigorous. Cast products which form part of such critical subsystems have to learn to relate quality costs directly with warranty and performance costs in the final product. As the chain of accountability in the manufacturing process becomes tighter, a casting supplier can no longer afford to think of just supplying products to a customer. The supplier is being forced to see the activity as part of the entire final product.

In the area of warranties, norms and practices are still evolving in the automobile industry. A day may not be far off, when a supplier of engine blocks or a supplier of pistons will have to give explicit performance guarantees in the final product. This naturally means that the other components in the assembly and the relation of the relevant assembly in the final product will have to be analyzed in much greater depth. It will also force co-operation and information sharing among players contributing to an assembly.

4.2 Logistics

A logistical analysis of cast components as part of the automobile industry in India has some interesting features.

Location and Transport: The foundry industry is concentrated in a few areas like Coimbatore (Tamil Nadu), Rajkot (Gujarat) and Kolhapur (Maharashtra) in India. For most assemblers, transportation lead times can be high and somewhat uncertain. As a precaution, some inventory (usually a few days or weeks) is held by these assemblers.
Cast components are often bulky and the transport costs can be significant. However, they are at an early stage of value addition and assemblers usually keep a significant amount of cast product inventory (the inventory costs being low).

**Inventory and Quality:** The rejection rate of cast components after machining can be significant and this is another reason for inventories of raw castings, so that assembly lines are not starved.

In terms of integration, the trend is towards tighter control of stage-wise and pipeline inventories, which again push firms upstream in the casting supply chain to integrate (as seen in section 3.4). There are very efficient small foundries where the cycle of material utilization (inventory turns) is very tight and lead times of two days for conversion from raw material to machined and dispatched finished goods is achieved, even for complex castings. Foundries in the Kolhapur area deliver to customers in Mumbai - 450 km away, every day, using smaller tonnage transport, if necessary.

**Sub-assemblies and Secondary Suppliers:** Assemblers are relying on suppliers for an increasing number of components and sub-assemblies, as opposed to simple parts. By doing so they are trying to reduce the complexity of both their assembly and purchasing operations. This also simplifies the logistical requirements of just-in-time manufacturing: even though the volume of supplies is not diminished, space at receipt stores is freed. Consequently, assemblers are now rearranging their supply chain. Now the direct supplier to the company assumes complete responsibility for providing the sub-assembly and, on its own or with assembler's guidance, selects secondary and tertiary suppliers. Companies in the second and third tiers are assigned the job of fabricating the parts. These suppliers are typically manufacturing specialists, usually without much expertise in product engineering but with strong backgrounds in process engineering and plant operations.

### 4.3 Design

Automobile assemblers have no option but to join the cycle of faster product development to suit customer requirements and environmental pressures. In India, a big challenge is to include suppliers in the design cycle. This calls for a very different style of manufacturing, since the majority of existing suppliers have very little influence or contribution to the final product design. We take a closer look at this issue in the following subsections.

**Design for Manufacture:** Earlier, suppliers used to provide some margin for unforeseen problems during manufacturing, leading to either higher quotations (possible loss of contract) or lower quotations (reduced profit or even loss). While long-term suppliers of a particular class of products are experienced enough to be able to suggest changes in product design which would improve its manufacturability (leading to lower costs, defects or lead-time), this capability is hardly ever utilized by the design engineers in buyer companies, owing to lack of channels for communication. Such suggestions may include minimum section thickness, diameter of cored holes, fillet radii or provision for a flat parting plane.

It is heartening to observe changes in the above scenario, specially where long-term or personal relationships have been established. Suppliers do not hesitate to suggest design modifications (specially when they make a significant difference), and buyers actively seek such suggestions.
In one particular case, the buyer company actually hired an experienced foundry engineer and placed him in the design team to provide suggestions for improving the manufacturability starting from the conceptual stage.

**Assembly Considerations:** With the increasing trend to procure sub-assemblies instead of individual parts, it is important to let the supplier know the way the components or sub-assemblies integrate with the final product. This is not only in terms of dimensional tolerances and critical (machined) surfaces, but also the assembly technique, process, performance and test procedures. Only with a better knowledge and understanding of the above, will the supplier be able to appreciate the requirements of the assembler and take measures to help in achieving them. For example, the foundry engineer, who knows how a heat treatment procedure will affect the dimensional stability over a period, will be better able to provide the correct allowances over the pattern or for machining to ensure that parts fit better in an assembly.

**Concurrent Engineering:** Sharing the design and manufacturing plans with a supplier enables him to plan his own supplies (raw materials, tooling) and schedule production to ensure the shortest lead time between order placement and delivery. In other words, advance planning and performing the tasks in parallel can dramatically reduce the lead time, but this requires communication, cooperation and coordination of respective activities between the assembler and the supplier.

Concurrent engineering becomes specially important in an age when design changes (innovations) are becoming more frequent to get more new models on the road faster than the competitor. With multinational automobile companies setting up manufacturing bases in India (many for exporting to other countries), the assemblers have no choice otherwise, and suppliers will have to fall in line.

**Information Technology:** In one case, we found that both assembler and its cylinder block and head supplier were using the same software package for drafting, without being aware of this fact. The assembler would continue to send the paper blueprint of the complicated drawing, which would then be recreated in the supplier's computer. The delay of 3 to 4 days could easily have been avoided if the drawings (or casting models in 3D) were sent on floppy disks. Such simple steps are the beginning of more advanced channels of communication, which include product data exchange through electronic mail, electronic quotations, billing and payment. The automobile giants now insist that the suppliers use the same computer-aided design and manufacturing (cad/cam) package, indeed the use of cad/cam is rapidly becoming an essential qualification for being considered a supplier. A number of specially developed software packages (such as pattern design and casting simulation) are available today and can be linked to the part modeling packages.

5 **Strategic Sourcing**

So far, we have discussed the emerging trends in assembler-supplier interaction and various factors leading to more deeper and fruitful partnerships. This requires taking a more long-term view of such relationships, in other words, a strategic approach to sourcing (from the assembler’s point of view). This is dealt with in some detail in this section, and further elaborated in a
separate report [6]. A recent comprehensive study discusses such practices in the electrical machinery industry in India [7].

5.1 What is Strategic Sourcing?

Strategic sourcing, as the name suggests, is the activity of procuring materials and services with a strategic intent. It involves the identification of long-term suppliers, the negotiation of critical supply parameters over the medium run, the setting of norms and performance improvement targets and the mechanism by which long-term joint investments and actions between the supplier and the customer are evaluated.

Strategic sourcing therefore involves realigning the supply base, supply base relationships, people, process and culture to achieve continuous improvements in total cost, quality and cycle time. Strategic sourcing provides a launch pad for greater innovation, faster time to market and higher profitability through supplier alliances or collaborative partnerships. Strategic sourcing is thus being viewed by auto makers as a significant tool to achieve competitive objectives.

5.2 Strategic Sourcing Teams

Earlier, sourcing of standardized components based on short-term considerations of price was more of a commercial activity. The new demands on the sourcing function require a wider array of evaluation and decision-making capabilities. This typically calls for a strategic sourcing team with people from materials, quality assurance, manufacturing and costing along with design personnel. This team makes all the key decisions associated with components and sub-assemblies, including vendor selection and certification.

The above change in sourcing methodology by the assemblers should be noted by the supplier foundries, who now have to interact with a cross-functional team of personnel evaluating the supplier from many long-term considerations, and not just cost factors as was the case earlier. The foundry’s capability to absorb or develop better technologies keeping in line with the assembler’s requirements would be a key factor. This may even require sharing the long-term plans of the foundry with the assemblers to inspire their confidence.

5.3 Types of Strategic Relationships

In general, a single methodology for strategic sourcing cannot be applied by all assemblers towards all suppliers. At the broadest level, this depends on the extent of mutual dependence between assembler and supplier, and on the dynamism related to both product and process technology involved. Since assemblers are reducing supplier bases, and typically suppliers, especially small and medium enterprises, would be able to cater to only a few (large) customers, the level of mutual dependence is increasing.

6 Conclusions

From the perspective of automobile assemblers, the broad trends of supplier base rationalization and strategic approach to sourcing seem well under way. This manifests itself in terms of vendor base compression, sourcing sub-assemblies instead of components, and emphasis on non-price competitive factors (quality, delivery and design). While the overall goals appear to be
reasonably well defined, individual companies are still experimenting with different modalities of defining and nurturing new relationships.

To suppliers, particularly small and medium enterprises (SMEs), this gives rise to both opportunities for increasing their contribution to the value addition in the supply chain (and thus more business opportunities). But there is also a serious threat of being dropped from rationalized supplier bases. If SMEs want to survive and grow, they have to adopt a more proactive stance to reposition themselves in response to supply chain trends.

We conclude here by listing out the advantages and disadvantages of partnerships for both buyers and suppliers (Tables 2 and 3).

Acknowledgements

Thanks are due to all those firms who willingly supplied information and material for this study.

References


List of Tables:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Adversarial</th>
<th>Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sourcing emphasis</td>
<td>Short term/operational</td>
<td>Long term/strategic</td>
</tr>
<tr>
<td>Supply base</td>
<td>Multiple sourcing</td>
<td>Single sourcing</td>
</tr>
<tr>
<td>Supplies</td>
<td>Parts</td>
<td>Subassemblies</td>
</tr>
<tr>
<td>Supplier selection</td>
<td>Based on Price (for standard products)</td>
<td>Based on capability, core competency</td>
</tr>
<tr>
<td>Information sharing</td>
<td>Drawings, quantities</td>
<td>Joint planning, improvements</td>
</tr>
<tr>
<td>Mgmt/tech assistance</td>
<td>Negligible</td>
<td>Significant</td>
</tr>
<tr>
<td>Ordering/receiving</td>
<td>Paperwork and invoicing</td>
<td>Telephone, fax, email</td>
</tr>
<tr>
<td>Order quantities</td>
<td>Large volumes in small batches</td>
<td>Small quantities in large batches</td>
</tr>
</tbody>
</table>

Table 1: Buyer-Supplier Relationships (synthesised from [1]-[4])

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced manufacturing and labour costs</td>
<td>Increased dependence on suppliers</td>
</tr>
<tr>
<td>Improved quality</td>
<td>Need to learn new negotiation style</td>
</tr>
<tr>
<td>Reduced complexity and cost of assembly</td>
<td>Lesser supplier competition</td>
</tr>
<tr>
<td>Supply assurance</td>
<td>Need to develop new managerial skills</td>
</tr>
<tr>
<td>Contract predictability</td>
<td>Increased support for supplier</td>
</tr>
<tr>
<td>Open book pricing assurance</td>
<td>Loss of contact with secondary suppliers</td>
</tr>
</tbody>
</table>

Table 2: Advantages and Disadvantages for Buyers

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract predictability</td>
<td>Sharing of cost information</td>
</tr>
<tr>
<td>Stable workforce and production</td>
<td>Decreased autonomy</td>
</tr>
<tr>
<td>Buyer assistance available</td>
<td>Pressure to assume complete responsibility</td>
</tr>
<tr>
<td>Increased R &amp; D support available</td>
<td>Increased communication and co-ordination costs</td>
</tr>
</tbody>
</table>

Table 3: Advantages and Disadvantages for Suppliers