A Collaborative Innovation Methodology Involving Clients, Plastics Moulders and Mould Making Industry

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ABSTRACT

The issue of vertical partnerships between large companies and their small and medium sized suppliers is not original. However, with the product life cycle reduction, the increasing level of product customization and the companies rising specialization in their core business have brought this issue to the frontline. Similarly, for some of the previous reasons, there is an increasing trend for the reduction in the production volumes for some products. In this paper a methodology for collaborative innovation is presented targeting the development of new business, organizational and technological approaches for small production volumes. The methodology is based on a strong collaborative work between the client company and its suppliers, attempting a reformulation in the design, the productive process and the business model, aiming a general target cost. The methodology will be applied on the design and production of a large plastic injected part for BRISA, a portuguese highway company, with an expected low market volume, finding new solutions that allow an increase in the competitiveness of the injection moulding process.

INTRODUCTION

The collaboration between companies, in particular between Original Equipment Manufacturers (OEMs) and their suppliers, targeting the development of innovation processes is not novelty. In fact, for the competitiveness sustention of industrial organizations innovation is becoming a determinant factor that requires hard and purposeful work, materialized in the integration of innovation processes as a part of their daily operations. However, if the competitive environment has pushed for a reduction of the product life cycle and for an increment of the customization of more and more complex products with high-quality standards, organizations have presented a tendency for an increasing specialization on their core competences/business. To deal with innovation in products and processes, highly systemic and multi-disciplinary as regarded the incorporated knowledge/ technologies, asks for an approach in which inter-organizations competences are connected, targeting common or complementary objectives in a well defined innovation network.

The establishment of such collaboration networks with suppliers and other partners allows the OEM´s companies to solve, in an innovative way, broad systemic problems, difficult to overcome through exclusively in-house solutions. By one side OEM´s can deal with such problems spreading the developing risks and reducing the required effort through the access of partners competences. By the other side, suppliers, and specially the small and medium sized ones, benefit from their integration in a market-driven innovation processes.

In this paper a structuralized innovation methodology is proposed, based on a strong collaboration between the OEM (client) and a net of actors, organized in a vertical partnership. Through the establishment of strong links between the OEM and its suppliers, challengeable objectives are defined, innovation drivers are identified and purposeful collaborative work is designed based on a set of actions evaluated a-priori accordingly to their potential contribution towards the objective and a-posterior through their effective contribution for the succeed. The methodology is applied to a particular case study in which the challengeable objective is to develop new technological and business approaches to allow the competitive production of low volumes of large parts in polymeric injected materials. Note that the objective is to enlarge the competitive domain of polymeric injected parts from the large volumes to the small series. The latter are typically the sphere of influence of not so reliable/ robust alternative process, due to the difficulties involved in spreading the cost of the mould in a reduced number of parts.

SUPPLIER INVOLVEMENT IN THE INNOVATION PROCESS

Commonly the manufacturing of a technological product involves many entities, constituted by a set of suppliers, who manufacture components that are later integrated and transformed by an OEM and traded ultimately with the final users. The specifications for the production and supply of these components are delivered most of times to the supplier as “a closed and frozen” concept, as for example, one list of specifications and drawings. The suppliers don’t have great chances to provide improvement and redesign suggestions on the basis of the tacit knowledge that they possess about the process.

A strategy to change this situation has been involving the suppliers in the early stages of the product development in order to incorporate manufacturing processes knowledge disseminated within the supply chain and materialize it in the product design. This methodology is known as Early Supplier Involvement (ESI) and many authors have underlined its importance [1] notability in the automobile industry [2]. ESI can facilitate the design of innovative solutions, improve the final product quality and, at the same time, reduce the time and the development costs.

Many OEM supplying companies are typically small and medium sized, highly specialized manufacturing business, on which the innovative capacity relies essentially in tacit knowledge, accumulated through experience after a long internal learning. The constitution of a partnership with a large company can be an opportunity for these suppliers to increase their coding and decoding capacities, to better value their tacit knowledge and, simultaneously, to reorganize their internal processes of innovation [3].

Despite the increasing number of experiences of client/supplier partnerships, a more close examination allows to verify that many of these partnerships are far from being systematic and structuralized, being many times a short term project based on a simple exchange of information and not a long term relation. In fact there are difficulties usually felt in early client/supplier involvement in innovation and product development processes, particularly related to a little emphasis given to how to put ESI into practice and how the available resources and tools can be used for this purpose [4]. More than this, the legal mechanisms and dimensions of participation and the managerial aspects that ensure positive results are not yet clearly understood.

The ESI concept relies on the supplier systematic participation in the development process of innovative products of their clients. In a broader perspective and considering the innovation framework, ESI should be considered within the wider concept of innovation networks (Fig. 1) promoted by OEMs, reinforcing the accepted wisdom that suppliers are innovation leaders within such environments.

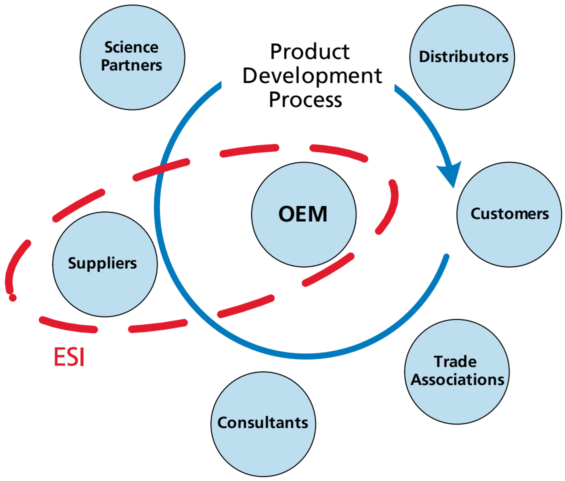

Fig. 1. A typical product innovation network centred in an OEM

Regarding the built mechanisms of innovation networks, two main types can be considered. The first one emerges and develops from the context when several entities share a set of common objectives and interdependencies. The second one (Fig. 1) requires the active role of promoters' entities for its construction and development. This second architecture type is characterised by the association of several partners around a central entity and it is used mainly as a way to achieve scale economies, to complement competences and increase knowledge and to share the risk of large scale innovation projects. Inside this type of network the collaboration client/supplier in product development processes is, at a lower level, a highly purposeful innovation network.

MOULD MAKING AND PRODUCT INNOVATION

Although mould making issues are a step in the product development chain, mould makers traditionally have been focused on production. They were given totally developed product designs including all frozen specifications and were asked for the production mould. Nevertheless, in the preceding years several authors [5],[6] have considered the widening of the intervention field of mould makers. As critical suppliers in the product development chain they have been pushed up to collaborate in innovation processes at an earlier stage integrating developing competences as regards technical prototyping and providing their manufacturing process know-how. The enlargement, upstream in the final product value chain towards the product/part design and downstream towards the product/part manufacturing, will create a set of new business opportunities for moulds industry, in areas of intensive knowledge and higher added value.

In terms of effectiveness, mould makers involvement in product development may lead to the reduction of product cost and to the increase of product value, both based on the mobilisation and leverage of expertises regarding design for manufacturing, part detail design and prototyping.

COLLABORATIVE INNOVATION METHODOLOGY

A collaborative innovation methodology was developed to promote the involvement of suppliers and other entities with OEMs along the product development processes. The methodology involves seven successive phases (Fig. 2):

1ST PHASE – INITIAL SPECIFICATIONS

In the initial phase the OEM (the client for its suppliers) outlines a preliminary description of the specifications and intended functionalities of the innovative product. If the new product is a module in a larger system, its restrictions and required interfaces must be fully detailed.

2ND PHASE – PARTNERS SELECTION

Based on the new product characteristics and on its innovation challenges, the OEM selects the core suppliers to integrate the development network. Typically these entities should emerge from the pool of partners of the OEM innovation network, being the ones more used to work with the OEM, with more relevant competences and more developed abilities as regards the innovation objectives. The number of partners to integrate should stay limited to evade some of the difficulties felt in the

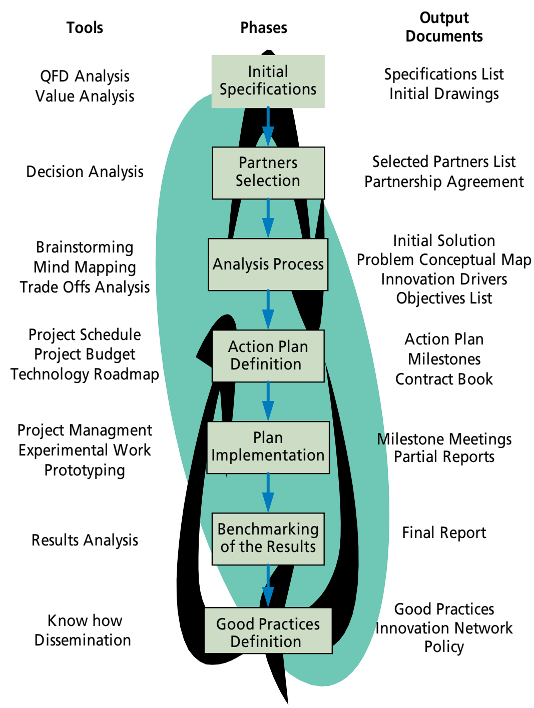

Fig. 2. Proposed Methodology

management of projects with a large number of participants, but should be sufficient enough to cover the different competences and achieve the required innovation effort. The core partners should carefully assess at this phase their openness and benefits in the project participation. A partnership agreement is delineated, with a clear but non restrictive definition of each partner obligations (including the OEM).

3rd Phase – Analysis Process

The analysis phase starts with a fine tuning of the product requirements and of the detailed objectives as regards engineering specifications and cost targets. Using the network knowledge the partners identify an initial solution, based on the current technologies and methodologies. For this solution the expected costs and other metrics are identify and the critical points of improvement are recognized. Following this initial solution, new solutions are outlined to improve the critical points identified and generate innovative approaches. One of the potential techniques to use all over this phase is brainstorming, within the objective of creating the conceptual map of the problem in analysis, gathering together large amounts of information and improving problem solving [7]. At the end of this phase the main innovation drivers and their potential impact to reach the defined objectives are identified. Sometimes along this phase and if the expertises of the partners involved in the network are insufficient, new partners may entry the network. Of course the partnership agreements must from the beginning set the rules of this process.

4th Phase – Action Plan Definition

At this phase, the adopted strategy for the development of each innovation driver identified in the previous phase is defined. The strategy involves a set of actions, quantified objectives and scheduled milestones. The responsibilities of each partner in the achievement of the objectives have to be clearly identified.

5th Phase – Plan Implementation

The measures considered in the Action Plan are applied for the various drivers. Along this phase the defined milestones could cause redefinitions in the previous phases. An example is the integration of new partners.

6th Phase – Benchmarking of the Results

With the conclusion of the implementation stage, results must be evaluate, quantified and compared. Partners' performance and his collaborative capabilities during the project are also analyzed. Supported by this benchmarking, the network evaluates and decides if the new proposals and their respective costs are compatible with initial main objectives.

7th Phase – Good Practices Definition

Based on the knowledge developed along the project, good practices are identified and a set of guidelines are built, recording all the outcomes achieved throughout the process. Beyond the more technological aspects, the issues of the OEM innovation network and its partners will have also to be analyzed and formalized. These good practices should be transmitted to the,partners to improve their technological knowledge and collaborative behaviour, improving the output of future projects.

THE CASE STUDY

The previous methodology was applied to the development process of innovative products of BRISA (OEM), a Portuguese highway company. BRISA is looking for new aesthetic image and added functionalities for the user interface of the equipments for automatic toll payment. A frontal cover panel for one of such equipments was selected as pilot project. Till now it has been made in sheet metal, bended, welded and painted, which deeply constrains design freedom regarding free forms and functional features issues.

Manufacturing technologies like polymers injection moulding are seemed like having a great potential for the reduction/elimination of these problems. However, considering that a few hundreds are the expected production volume of such panels, technologies involving moulds have been set aside due to difficulties in accommodate the mould cost in the panel final cost. An innovation breakthrough is required to support the injection moulding penetration in small volumes market niches.

Tools, such as Quality Function Deployment (QFD) were used to compile from the client (BRISA) point of view a starting list of the part specifications, with various metrics, from functionally/quality features to target costs. An innovation process was launched, and the first step was to set-up the network involving suppliers that integrate capabilities in mould and part production and entities from the scientific and technological system. Based on expertise and experience of the partners the engineering specifications were adjusted to the requirements and the starting solution of the problem was defined. The objective of such definition is to have a clear overview of the current solutions provided by the industry to the problem: "produce 200 panels using injection moulding as the core technology". The panel specifications were given to process engineers and mould designers and they were asked for a suitable engineering solution. The outcome manufacturing chain demonstrated its inadequacy. Although the production volume was established the engineers and designers involved set a conventional mould engineering solution based on aluminium, which is the current injection moulding approach for small (but not so small) volumes. In fact the traditional aluminium mould when a so small volume is envisaged has a high cost and is not value driven – the mould value is related to its capacity to produce 200 parts but the aluminium mould is over-dimensioned as it can certainly produce tenths of thousands parts without difficulties. As far as the estimated cost of the panel is far from its target cost (target price minus a mark-up) and 70% of the panel cost was related to the mould a reverse engineering analysis was launched. The objective is to perform a systematic evaluation of the panel value chain focused on cost reduction.

The improvement drivers for accomplish the main objective were identified and classified in respect to their potential contribution (1–higher, 4–lower) for the part cost reduction (Fig. 3).

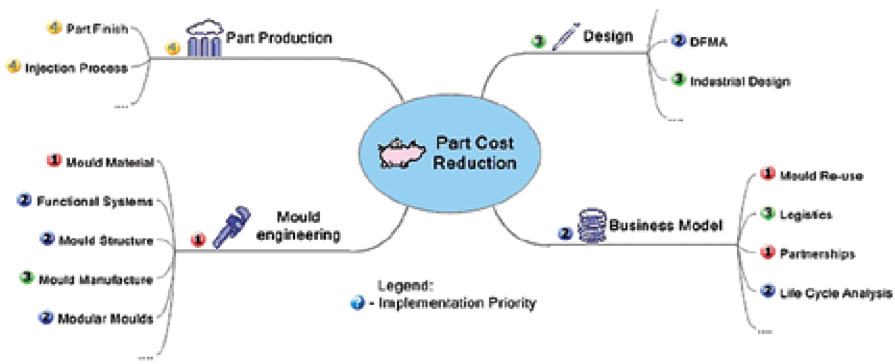

Fig. 3. Problem Conceptual Map: improvement drivers and implementation priorities

Within these drivers framework, innovation strategies were outlined. Without being exhaustive, some are listed below:

Mould Engineering:

- Use of low cost materials and easy to machine materials;
- Systematic questioning of the need of any mould functional sub-system (elimination /simplification, new solutions);
- Use reusable and shared mould components/ sub-systems;
- Use of recycling materials;
- New technologies in mould manufacturing (casting, additive technologies, among others)

Design:

- Simultaneous part and mould design for effective design for manufacture and assembly;
- Use of low cost/easy to inject part material
- Business Models:
- Long-term partnerships with the client
- Explore new opportunities along the value chain (Fig. 4)

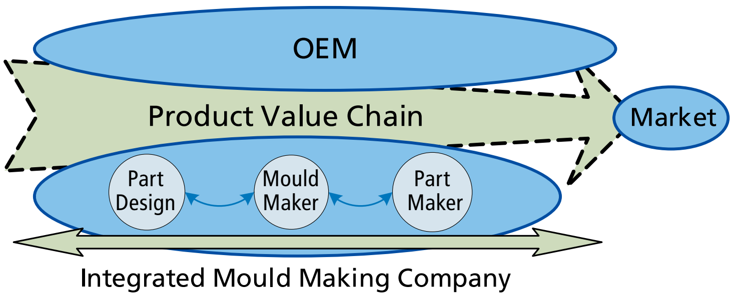

Fig. 4. Mould value chain integrated approach

As regards the new opportunities along the value chain it should be remarked that BRISA is demanding for 200 panels and only will pay the delivered parts. The supplier ("integrated mould-making company") must develop in-house competences to allow a quick and responsive market answer. As it will be the owner of a short life cycle mould, issues like modular moulds, recycled materials, reuse and share of mould sub-systems are issues of significant importance. Moreover, assuming that the cost objectives require the development of tailored solutions, the success depends on long-term client/supplier partnerships to facilitate the workflow.

The planed actions are already in course. Each one is being experimented and the results are being evaluated considering the part conformity to the technical specifications and to the target cost. The benchmarking will drive the future work and will allow the tailored of the final approach to answer the initial challenge.

CONCLUSIONS

Although the presented case study is not concluded, some conclusions can already be pointed out. With the supplier involvement and the innovation network the OEM gets innovation inputs for the business not relying only on the in-house frontiers. Mould-makers (suppliers) get involved in high added value activities, become co-designers and co-manufacturers of products and increase their innovative and organizational capacities with large exploitation opportunities in other sectors. The Innovation Network should go beyond the OEM – Supplier (ESI) relation and look for the involvement of partners from the Scientific and Technological System. Finally, questions related to the project coordination, the clear identification of the objectives and innovation drivers, partners roles and responsibilities are considered crucial for a succeed outcome.

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