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Strategic Priorities and Lean Manufacturing Practices in Automotive Suppliers. Ten Years After.

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1. Introduction

Currently, automobile manufacturers have transformed their philosophy of production in favour of the lean manufacturing paradigm. By doing so, they hope to improve efficiency and to obtain better results in the markets in which they operate. This transformation must occur not only in their plants, but it seems important that their suppliers should also modify their production systems in line with the lean manufacturing philosophy (Liker & Wu, 2000; Morris et al., 2006; Oliver & Delbridge, 2002). The effects of this wave will probably result that one integrated supply chain can be built.

Supply companies can see benefits from the implantation of lean manufacturing practices in certain of their strategic priorities, be they quality, lead-times or costs.

On different matters, there appears to be sufficient empirical and theoretical evidence to affirm that human resource management practices play a very important role in the successful implantation of lean manufacturing and above all in its maintenance thanks to the creation of a continuous improvement culture that supports the other lean manufacturing practices (Garcia-Sabater & Marin-Garcia, 2010).

The objective of this chapter is to present an architecture of lean management practices, indicating the implantation sequence recommended for suppliers and the necessities that can help to resolve each one of the practices. We will also describe how, over the past decade, the necessities as much as the practices of lean manufacturing have evolved using some Spanish automotive suppliers as examples. Finally we will analyse in detail the evolution of continuous improvement programs to support lean manufacturing in 11 companies that had started their deployment in the year 2000 (Marin-Garcia et al., 2009).

2. Lean manufacturing

The environment in which most industrial companies find themselves is characterized by the rivalry with competitors, the speed of change and the instability of demand. The majority of their markets are mature and their customers demand quality products that fit their specifics needs, one of which is the demand for quicker and more regular deliveries

(Marin-Garcia et al., 2009; Peng et al., 2008; Devaraj et al., 2004; Ketokivi & Schroeder, 2004). Everything seems to indicate that this tendency will only increase in the future. With this in mind, it is advisable that companies position themselves and decide their strategic operation priorities (Urgal González & García Vázquez, 2005; Ketokivi & Schroeder, 2004; Martín Peña & Díaz Garrido, 2007). Currently a consensus exists regarding two large blocks of strategic priorities in the area of production. Companies whose principal corporate strategy is the emphasis on costs will see as priority the efficient management of operations (reduce costs, investments and inventory) (González Benito & Suárez González, 2007; Avella et al., 2001; Ketokivi & Schroeder, 2004; Hayes & Wheelwright, 1984). Those companies that emphasise differentiation will see the quality operations area as priority (error free products and quality as perceived by the customer); or flexibility (range of the product line, modification of production volume or mix and design modifications) or delivery (production cycle time, delivery speed and on time delivery) (Lewis & Boyer, 2002; González Benito & Suárez González, 2007; Avella et al., 2001; Devaraj et al., 2004; Ketokivi & Schroeder, 2004; Hayes & Wheelwright, 1984; Lewis & Boyer, 2002).

According to some authors it is difficult for a given company to satisfy all these priorities at the same time, given that there exists incompatibilities (trade off) between them (Avella et al., 2001; Devaraj et al., 2004; Skinner, 1969). However, there are also investigations where a sequential or accumulative model is proposed (González Benito & Suárez González, 2007). According to this model the companies focus on a few priorities at any given moment, but once they are satisfied they move onto others without losing the developed abilities. In this way they accumulate abilities that allow them, over time, to simultaneously satisfy a wide range of priorities.

Currently, to combat competitive pressures, it is necessary to complement the efforts towards continuous improvement in production and quality being made since the eighties (White & Prybutok, 2001; Suzaki, 1993; Vazquez-Bustelo & Avella, 2006). To this end, it is necessary to identify problems before their consequences are seen, to analyse solutions for the suppression of unnecessary activities; and to reduce fabrication time, change over time and batch size (Garcia-Sabater & Marin-Garcia, 2010; Marin-Garcia et al., 2008; Marin-Garcia et al., 2009). These activities are the basis of a group of practices that shape systems of advanced manufacturing. These systems have received many names, amongst others: lean manufacturing, just in time, total quality management or world class manufacturing. There exist many similarities in these concepts (Prado Prado, 2002; White & Prybutok, 2001; Marin-Garcia & Carneiro, 2010). To sum up, the objective of these practices is the systematic elimination of all types of waste (Callen et al., 2000), considering as waste anything beyond the minimum needed in terms of equipment, materials, components, space or worker time to give added value to the products (Suzaki, 1993).

To put lean manufacturing systems into place, it is proposed a group of practices related to operations management (production planning and control, materials flow, maintenance system, quality system...), the relationships with clients and suppliers, product design or human resource management (participative management, worker involvement...). Amongst the most common we can find the following (see Table 1)(Shah & Ward, 2007; Dabhilkar & Ahlstrom, 2007; Jorgensen et al., 2008; Gurumurthy & Kodali, 2008; Carrasqueira & Machado, 2008; Marin-Garcia et al., 2006; Marin-Garcia & Carneiro, 2010; Treville & Antonakis, 2006; Doolen & Hacker, 2005; Marin-Garcia & Conci, 2009; White & Prybutok, 2001; Prado Prado, 2002; White et al., 1999):

Practice	Definition
Visual Management (VM)	The whole workplace is set-up with signs, labels, color-coded markings, etc. such that anyone unfamiliar with the process can, in a matter of minutes, know what is going on, understand the process, and know what is being done correctly and what is out of place.
Continuous Improvement (CI)	Incremental improvement of products, processes, or services over time, with the goal of reducing waste to improve workplace functionality, customer service, or product performance.
Total Quality Management (TQM)	Establish quality as the top priority of the organization's business objectives. This includes involvement in the quality effort by all functions and employees and implementation of statistical quality control methods for defect prevention is an integral part of the program.
Process Standardization (SOP)	Systematize how a part is processed, and includes man-machine interactions and studies of human motion. All tasks are organized in the best known sequence and by using the most effective combination of people, materials, methods and machines.
Reduction of Set up time (SMED)	This practice would attempt to reduce the time and costs involved in changing from the tooling, layout, etc. required to produce one product to that required to produce other products.
Total productive Maintenance (TPM)	Attempt to establish and refine routine preventive maintenance and replacement programs, getting machine operator actively participating in the minor machine maintenance functions in order to eliminate losses tied to equipment maintenance or, in other words, keep equipment producing only good product, as fast as possible with no unplanned downtime.
Just in Time (JIT)	To make one piece at a time correctly all the time, without unplanned interruptions and without lengthy queue times. Everything that is needed to process the part is within easy reach, and no part is allowed to go to the next operation until the previous operation has been completed. Ensures that suppliers deliver the right quantity at the right time in the right place.
Supplier relationship (SR)	Develop suppliers so they can be more involved in the production process of the firm. The objective is to improve quality, flexibility and levels of service form suppliers by increasing the quantity of orders, reducing the number of suppliers and developing a long term relationship based on trust and providing regular feedback to suppliers about their performance.

Customer relationship (CR)	Focus on a firm's customers and their needs with closer customer-company relationship, customer needs surveys, operation integrated with those of customers and delivery quality information.
Design integrated with manufacturing (DFMA)	Designing products in such a way that they are easy to manufacture, choosing the right material, the machines and processes used to work the raw material, and the assembly of the product.
High Involvement Work Practices (HIWP): empowerment, training and rewards	Consistently advocates a bottom-up approach to management. Jobs at the lowest level are thought to be best designed when individuals or teams do a complete part of an organization's work process, such as making an entire product or providing a complete service. Ensuring that people are fully trained and truly empowered and installing "enlightened" and realistic performance measures, evaluation, and reward systems

Table 1. Common lean manufacturing practices.

In diverse papers it has been stated that the application of these practices has beneficial effects for the given company. These effects are greater if large groups of practices are implanted, and not in an isolated way, taking advantage of a synergetic effect between them (White & Prybutok, 2001). Thanks to lean manufacturing companies can improve their productivity as much in terms of workforce as machinery, and can reduce time between receipt of order and completion of production, can improve internal and external quality and reduce inventory levels and unit costs (Callen et al., 2000; White & Prybutok, 2001; Marin-Garcia et al., 2009). All of this allows an improvement in competition.

The majority of experiences related to lean manufacturing have taken place in companies that make elevated quantities of the same product in repetitive processes (production lines). Amongst these the automobile industry, and its auxiliary companies, and the consumer electronics industry stand out. However, jobs that justify the benefits of these systems also exist in other sectors, as much in process companies (food, chemicals, pharmaceuticals, detergents...) as other types of company (textile, industrial machinery, metallic components, compressors, hydraulic valves, electrical consumer goods, plastics...)(Schonberger, 1996), even in those companies that make highly differentiated products of which few of each model are made (James-moore & Gibbons, 1997; White & Prybutok, 2001). Nevertheless, we have to take into account that the use of these practices is most seen in companies with repetitive configurations (line or process) than in those with non repetitive configurations (projects or workshops) (White & Prybutok, 2001). As well, the results obtained by companies are relatively better with repetitive configurations, where complex and standard consumer products are made. However, other types of processes can also be improved with these techniques, although at a lower level (Lee, 1996).

On the other hand, it appears to be demonstrated that plants with less than 250 employees use these systems less (Schonberger, 1996; White & Prybutok, 2001). For smaller companies it is better to undertake a sequential implantation of those tools available to them, starting with the easiest and cheapest. Perhaps even for bigger companies this is the most efficient tactic for launching lean manufacturing.

Taking into account the fact that the implantation of these practices is a gradual process, it is vital to reflect if it is possible to find the most appropriate order in which the practices should be put into action in the auxiliary automobile industry (Marin-Garcia et al., 2010). A general proposal exists by Monden (1998) and, in this paper, we will present an adaption to the particular necessities of the sector upon which we are focusing. We will begin with describing how, over the last decade, the necessities as much as the practices of lean manufacturing have evolved in a Spanish automotive supplier sample. We will also analyse the evolution over these 10 years of those continuous improvement programs implanted to give support to lean manufacturing in 11 companies within the sector. From these experiences a proposal for a lean manufacturing practice architecture will be proposed, indicating the implantation procedure most appropriate for automobile supplier companies.

3. Evolution of the use of practices and priorities

The grade of deployment of lean manufacturing practices has been analysed via a survey taken by Spanish companies belonging to the cluster of suppliers to the automotive industry. The majority of these companies are small and medium sized (Table 2) and there is no a significant difference between the samples from the years 2000 and 2010, although over this decade there had been a process of concentration that gave origin to mergers, acquisitions, and closures, generating an increase in the number of large companies in the sector.

Workers	2000	2010
less than 50	39%	24%
between 50 and 249	48%	56%
250 or more	13%	21%
N	31	33

Table 2. Distribution of companies by size.

The data that we are going to present in this section were obtained via a questionnaire within which companies were asked about the level of deployment of the different practices with a range of answers between 0, nothing, up to 5, very much (Marin-Garcia & Carneiro, 2010).

In Figure 1 we show the evolution of strategic priorities in the area of production. Over these 10 years the relative importance of priorities has changed, although the principal priorities in 2010 continue to be lead-times and the reduction of defects. However, in these 10 years, the necessity to fight competitors on the basis of cost has moved from third to eighth place, and to achieve an increased workforce productivity has changed from penultimate to fourth place. We can appreciate how the sensation of having to attend to all competitive factors has increased over the decade, and that current companies score the 11 dimensions with a grade of importance greater than 4, while in the year 2000 there were 6 dimensions with an importance of below 4. Without a doubt this has increased the complexity of operations management in having to try to simultaneously improve diverse indicators that, in some cases, can have some grade of incompatibility. Lastly, to highlight that the increment of strategic priorities is statistically significant in 5 of these (to increase the flexibility to modify products, attend to variable demand, reduce leadtimes, to integrate production decisions with the company strategy and to increase workforce productivity).

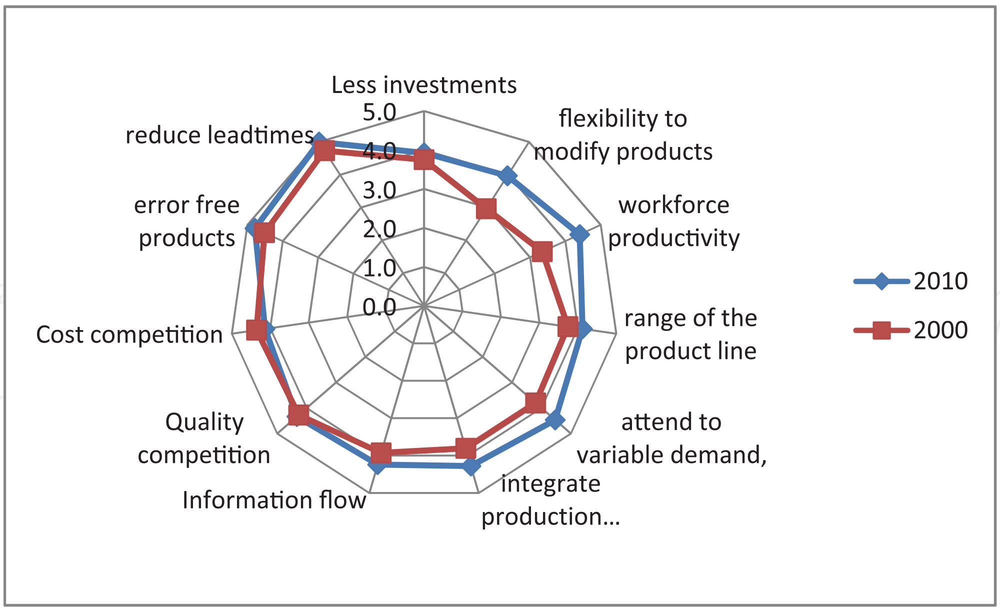

Fig. 1. Evolution of competitive priorities in operations management.

In Figure 2 we show the evolution of deployment of lean manufacturing practices. The differences are statistically significant in all except preventive maintenance, supplier relationship and JIT with suppliers. TPM and supplier relationship were at a high level of deployment in 2000 and have remained amongst the most developed in 2010. The third was one of the least used in 2000 and continues to be one of the most complicated to implant in 2010. In part because it requires the prior deployment of other tools than still have not achieved an adequate level of development in the sector, and in part because second level suppliers are smaller companies with fewer resources that encounter many difficulties when implanting and maintaining lean manufacturing in their companies. However, over these 10 years the grade of implantation of practices such as SOP, SMED, customer relationship, internal JIT and empowerment has increased greatly, allowing that the sector has passed from an initial stage to a moderate deployment of lean manufacturing practices.

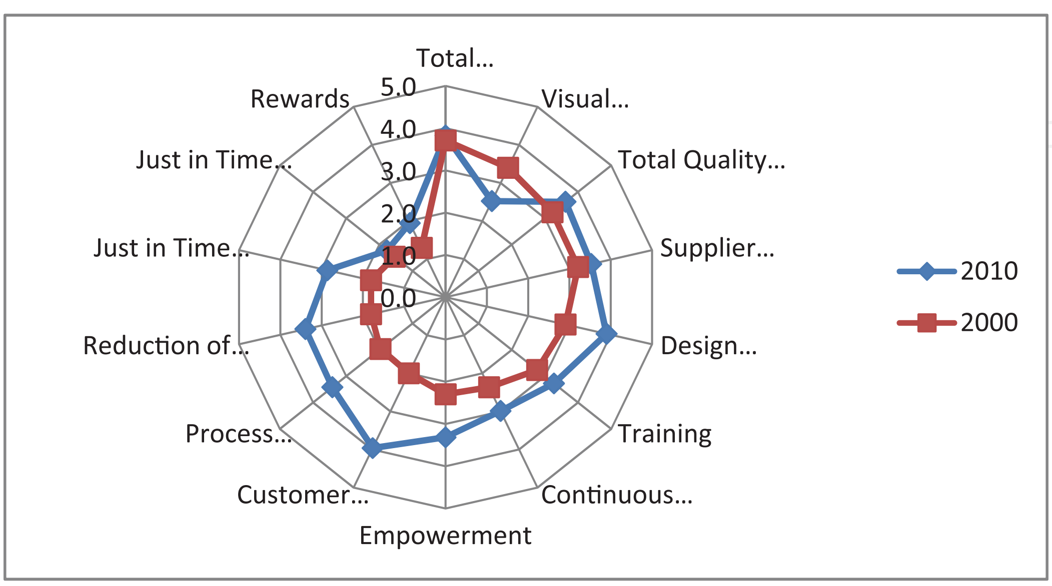

Fig. 2. Grade of use of lean manufacturing practices.

The only practice that has fallen back in its grade of use is visual management. Perhaps this is due, as we will see in the next section, to the fact that in the year 2000 companies had just launched these practices (those which all companies began with) and, with time, the practice has diminished in use for a lack of discipline in maintenance. It could also be due the ever more frequent use of computers in the collection and analysis of data while the use of informative screens (touch screen or not) has not been popularized in production lines; which means that the information that previously was distributed on paper (and even hand written) is now transmitted in electronic format, without having achieved the visual impact of traditional procedures.
To complete the analysis of the evolution of the last decade, in the next section we are going to comment upon how the process of deployment has been in 11 companies that have in common having taken part in a development programme for automotive suppliers around the year 2000 (Marin-Garcia et al., 2009).

4. Evolution of continuous improvement programs to support the implantation of lean manufacturing

In this section we resume the qualitative investigation undertaken in 11 companies from the previous sample. These 11 companies participated during 2000-2001 in a series of Kaizen events led by external consultants (lean managers of the main client) with the objective of deploying lean manufacturing in the company. These companies, belong to different industries and manufacture various products, among which are soundproofing, metal stamping, welded parts, nuts and bolts, plastics (injection and moulded), mechanical sets and electrical products.
All the companies received the same intervention, summarised in the four steps described below:

Step 1. Selecting the line or process to be observed in the plant.

Step 2. Initial diagnosis of the situation of the line selected. This diagnostic period usually lasted 2 days.

Step 3. Development of the Kaizen-Blitz activities and action. A workshop dynamic of 4-5 complete days duration was used, under the guidance of expert consultants. Groups of 5 to 14 people participated in the workshops, half of whom were workers. These tools ranged from 5S tools, visual factory and re-design of layouts for the less developed plants in lean manufacturing, to Kanban or TPM techniques for those in which some others tools had already been introduced. At the end of the week, the group had developed the chosen improvements and had proposed an immediate action plan for further improvements that would require the approval of the management. Finally, a date was agreed for follow-up on the evolution of the indicators of productive efficiency. This process was repeated two or three times in each company during a 9-month period until the objectives specified in the initial diagnosis was fulfilled. In other words, two or three Kaizen events were carried out in each company.

Step 4. Drafting a report to reflect the summary of the activities, to be added to the research database.

The main results obtained in the eleven cases analysed are summarised by a notable improvement in the efficiency of the machines (approximately 18%), mainly obtained due to a radical improvement in the changeover time (reductions of almost 60% of the original time); improvement in the quality rate of nearly 5%; reduction of inventory levels by almost 40% and an increase in productivity between 9% and 60%. Along with this, we also detected important improvements in the use of the space in the plant, a reduction in the number of containers and the distance travelled by products (Marin-Garcia et al., 2009).

We interviewed the production directors of these companies with the objective of learning how they valued the workshops undertaken ten years ago, what was the deployment process of lean manufacturing after that experience, what difficulties they found and how they overcame them (Fendt & Sachs, 2008; Charmaz, 2006).

The majority of the interviewees do not doubt that the experiment was a success. To value it in this way is not only based on the positive evolution of the Key Performance Indicators (KPIs) such as FTT, OEE, DTD or productivity (see below), they also take into account the impulse needed for the deployment of lean manufacturing, or the knowledge that it allowed them to attain. In this sense, the involvement of the consultants was valued, the practical experience they had, and the transfer of real solutions that had been tried in similar situation. For many of the interviewees, these workshops from 10 years ago showed them "all I know about lean manufacturing". However, not all the opinions are favourable. In a few companies it is considered that "it isn't worth anything", "the customer came to sniff around our processes and to impose a cost reduction, with hardly any help in achieving this end". It is interesting to observe that the assessment of success or failure of the workshops did not depend on whether the company had begun or not the path towards lean manufacturing before the arrival of the external consultants. Although it is possible that the action of the consultants was not exactly equal in all the companies, it appears to be more probable to think that the reaction from the companies can be seen as culturally conditioned (there are companies where they do not like it when outsiders come to tell them how to do things, or that try to introduce methodologies that clash with company or holding group politics), or for reasons of commercial friction far from the Kaizen events.

With respect to when the companies began the deployment of lean manufacturing, the majority undertook it around 2000. One company had started with lean manufacturing implantations around 1995. Another company began in 1999 with 5S, SMED and TPM. Amongst the others, some had undertaken Kaizen events after the continuous improvement approach, but without a methodology of lean manufacturing deployment perspective. Other had not undertaken anything more than have started up a suggestions system. Therefore, for the majority, the first real contact with a lean manufacturing deployment was the Kaizen events. The evolution over the ten previous years differed in each of the companies. However, two groups can be seen.

The first of these, the most common, is the gradual loss of impulse once the Kaizen events are over. The attained achievements and the initiated dynamics gradually degraded and, after 12-24 months, the situation with respect to lean manufacturing was very similar to that of the year 2000. Perhaps not all of the tools lost their effect. For example, it has been stated that some maintenance of 5S and SMED has been seen. But in general terms the system remains at 15-20% of what it could have achieved if the implantation had been continued. The motives for this were principally the lack of management support. In some cases because "they didn't believe in the system" or "the management support was like a theatre, the client wanted us to do it so we did it". In others, due to the fact that the growth in business overwhelmed capacity and "to attend to urgent matters robbed us of time we were able to dedicate to important matters". Another common cause for the fall off in the system was due to the companies not being able to give the necessary resources for the system to work. One of the resources was money for small investments. But the principle resources lacking, in the opinion of the managers interviewed, was the ability to dedicate the time of someone who took command the lean manufacturing deployment or the ability to free up workers from the production line so they could dedicate some time to working on the pilot production line in lean manufacturing tools. This difficulty is still current in the year 2010 in some companies. Lastly, another cause for the interruption in lean manufacturing deployment was the wear and tear that it generates in those who keep the systems moving. These people have to be convincing management and workers alike, training, following, paying attention to possible improvement methods... and this task is never done. Something which can begin as an interesting challenge ends up becoming "a pain when the necessary support and resources are not available".

The second group is characterized by companies who continue with lean manufacturing system deployment, and some of the first groups that one, two or three years after they stop it (which is to say 4-5 years after the first implantation) decide to look again at, and restart, the implantation of lean manufacturing. In these cases, the principal driver of the new initiative comes from changes in management personnel. All the companies in this group coincide in that the success of the continued implantation is based in various things. Perhaps the principal is the explicit support of management. Another, very important, is to achieve a change in culture to highlight a philosophy of continuous improvement where the maintenance of improvements is seen as important as putting them into place. In this sense, standardization is a key part in sustaining the system. This cultural change has been brought about by training and "preaching the example" by management. The third of the key things seems to be "most focused" which is to say all the actions are focused to achieve something, and it is available a system of indicators (KPIs) to confirm, in time, whether everything is going according to plan, and in the case of problems that can guide as to which corrective actions are necessary. Lastly, those polled agreed that the existence of a "lean champion", with either full time or part time commitment to the role, is crucial to make sure all functions as it should.

5. Proposal for the lean manufacturing implantation process

Starting with the experience of the companies interviewed, the implantation process should begin with the breaking down of competitive priorities into KPIs that allow us to measure how the company is evolving. In the auxiliary automotive sector it is common to find these indicators (Maskell, 1995; Giffi et al., 1990; Dal et al., 2000; Suzaki, 1993):

- Production: Manpower productivity.
- Quality: FTT (First-Time-Through); customer returns/warranty; rejection/rework
- Cost: Buying cost/unit produced; cost of logistics; Dock-To-Dock (DTD), Overall Equipment Effectiveness (OEE), Build To Schedule (BTS).
- Delivery: Delay in delivery, lead time.
- Safety: Accidents.
- Morale: Employee satisfaction surveys, number of suggestions, absenteeism, turnover.

When the company has chosen its priority indicators it is advisable to undertake a prior diagnostic and the drawing up of a Value Stream Map (VSM) (Tapping et al., 2002; Rother & Shook, 1998). In this way, the current state can be documented and a better focus towards that which most interests the company can be considered. With the data from the diagnostic the most suitable pilot area can be chosen, along with the group of action to be undertaken.

Perhaps workers can be involved in the diagnostic, with this helping to start the implantation process.
In general, it is possible to draw up an itinerary for the recommended implantation order of the tools. Although we must take into account that the sequence proposed can need to be altered in an actual implantation, in function of the analysis of the diagnostic undertaken by both the project team and the external experts collaborating in the implantation.
The next stage following the diagnostic would be to raise awareness and to involve all personnel in the process of continuous improvement. Often the deployment of some 5S followed by visual management can be a good start in the pilot area if it is combined with the use of human resource management practices (training, empowerment and rewards), in such a way so as to achieve worker commitment and so the worker takes on board and even brings about the necessary changes in the company (Lee, 1996; Lee, 1996; Martínez Sánchez et al., 2001; Lawler III et al., 2001).
Following this, if the company has automated processes, it is convenient to undertake the implantation of SMED and TPM. The next stage, for those companies that need it, would be line balancing and cellular manufacturing.
Standardization of processes is advisable between each of the processes thus far commented upon, to maintain the advances achieved. Afterwards JIT and Kanban systems can be looked at.
In parallel, there are other practices that can be gradually incorporated, enough to satisfy the competitive necessities. We refer to integrated design, TQM, client relationships and supplier relationships.
The Figure 3 represents the stages thus far stated. The tools on top act as support and should be present in all implantations. Those on the right complement other system tools although it can be said that they are not necessary in all companies, or do not have an exact moment to be placed into action (they have fewer precedence restrictions than other practices represented in the figure).

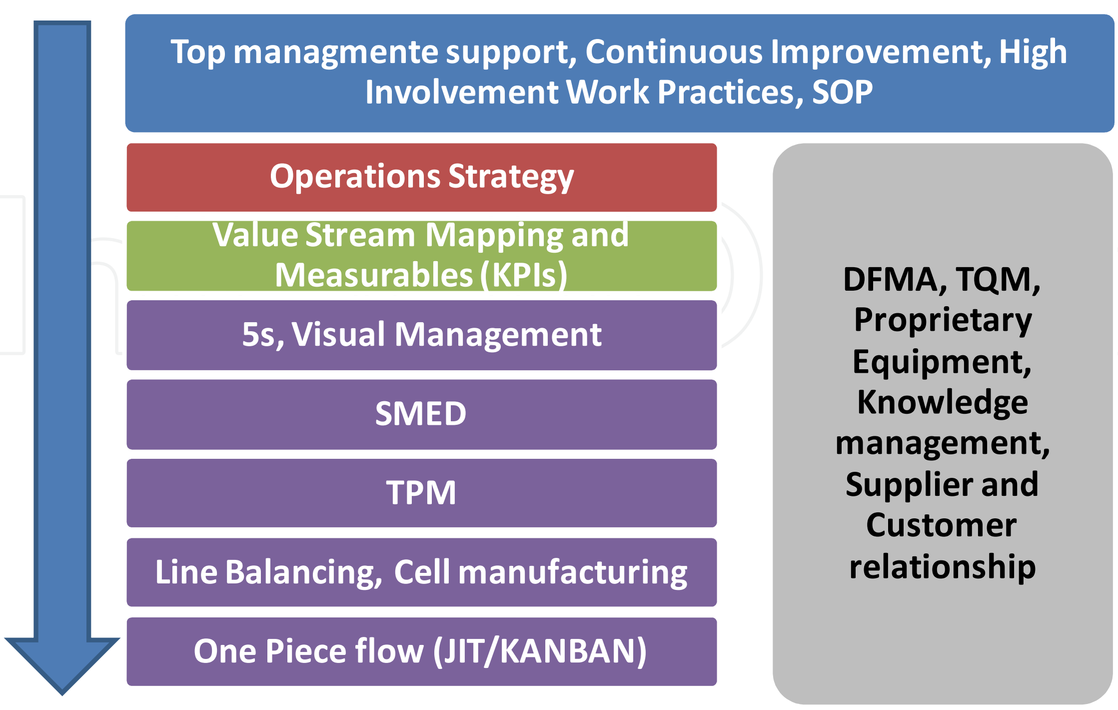

Fig. 3. Implementation process

6. Conclusion

In this paper we have analysed the different practices of lean manufacturing, the evolution of its grade of use in the auxiliary automotive industry between 2000 and 2010 and how this evolution has been experienced in some companies.

Starting from the experience of a group of companies, a success lean manufacturing implantation process should have the following steps:

1. Explicit support from upper management: implantation requires continuous effort from the whole company. Much can be gained from implantation, but it is necessary to maintain constant striving towards continuous improvement. Towards this end it is advisable that all personnel are clear that the upper management unconditionally support the project and provide the necessary resources.
2. The establishment of a project team to lead the implantation. Heading this group it is convenient to have a lean manufacturing “champion” or leader. The objectives of this team are usually, amongst others: spread good practice throughout the company, provide training on tools and techniques, and establish implantation objectives and to supervise the advancement. Probably the support of an industry cluster association would be the key in giving support to these teams.
3. Choosing a methodology that guides and structures the implantation project.
4. Selection of pilot projects and the progressive deployment of the implantation.

The order in which practices are implanted suggested by us in the implantation process section allows a progressive construction of a solid base for lean manufacturing. First phase practices tend to be easier to implant, but we must advise that even the simplest practice is complicated to maintain, thus meaning a change in attitudes and collective conduct is necessary. Support, supervision and constant reminder from upper management is required so that the gains obtained from the implantation are maintained over time, and so that we do not return at the beginning.

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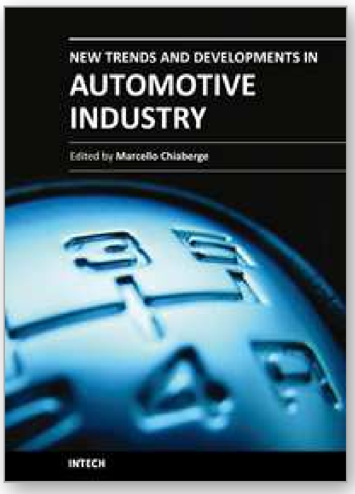

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