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# International Journal of Automotive Industry and Management

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Bernard Jullien

A Framework of Sustainable Development Issues for the Automotive Industry

Abstract - The GERPISA project will focus on the question of trade-offs and synergies between the different dimensions of sustainable development in the automobile industry. It retains the definition of SD, predominant in 2007, which considers as sustainable the development that guarantees compatibility between economic competitiveness, social responsibility and environment protection. This obligation to integrate the three dimensions of SD and to achieve synergies between them is increasingly significant at both corporate and public policy level. Reference to this ‘new framework’ has grown in importance over the last decade to the point where it is now in the process of being translated into both discourse and practice. In this context of growing operationalisation of the framework, the GERPISA project is based on the belief that reference to the principles of SD alone is no longer sufficient and that an analysis of the practices is now required. In analytical terms, it is, therefore important to contrast the notion of trade-off with the notion of synergy. This is necessary to understand the discrepancies between practices and discourse, to investigate the diversity of interpretations and to develop a realistic understanding of the changes related to this new framework. As a result we will be able to measure and analyse the variability of the practices associated with the implementation of the new framework at European level, and at the global level we will be in a position to evaluate the European specificity in this area. This double evaluation will be carried out with two main research axes. The first will focus on the practices of the enterprises, and the second on the design of public policy.

Keywords - Sustainable development, Economic competitiveness, Social responsibility, Environment protection, GERPISA

Social science research into sustainable development has progressively led to the constitution of specialised academic communities that view questions raised by the proliferation of these kinds of societal demands as a breeding ground for new sub-disciplines. One example is the field of economics, with the rise over the past 20 years of an environmental corpus that has tended to monopolise economists’ scientific output by replicating the main theoretical oppositions that already serve to differentiate this discipline’s main schools of analysis. Something similar has happened in management’s different sub-sectors, each of which has its own way of incorporating sustainable development, with design specialists beginning to talk about “eco-design” marketing experts about green or “ethical”

Bernard Jullien is a senior lecturer in industrial economics at Universite Montesquieu, Bordeaux IV and he is the Director of the GERPISA international research network on the automotive industry based in the Universite d’Evry. His primary research field concerns car distribution and, more broadly, automobile usage. (e-mail: bernard.jullien@u-bordeaux4.fr)
marketing, etc. Since each sub-discipline has its own way of giving voice to these discussions, what we end up with are specialised communities engaging in standalone debates on sustainable development and publishing their findings in specialised reviews.

Firms and public administrations have also jumped on the bandwagon, setting up sustainable development departments whose existence seems to substantiate researchers’ autonomy from their discipline of origin. As these new specialists often affirm, however, the development of practices apt to satisfy companies’ sustainable development requirements, and the establishment of public policies conducive to such practices, implies a modicum of synergy between all of a firm’s practices, and/or with the other public policies that exist to influence and/or regulate firms’ varying practices. Accepting the need for coherence is tantamount to advocating a de-compartmentalisation of research, whilst preserving the ability to ascertain the conditions for effectiveness of these practices or policies.

A brief analysis of the literature produced under these specialised approaches both in economy and management (and of sustainable development policies) indicates a strategy of ignoring problems and/or compatibility complexity issues - the implication being that the preferred way of achieving coherence is to subject all practices and policies to sustainable development aims. The implicit hypothesis is that principles or aims defined in reference to sustainable development are both compatible with one another and also likely to supersede any of the other principles or aims that might govern productive activities or public action. The merit of this avoidance strategy is that it provides a tool for developing and subsequently exploring the new field, thereby constituting a solid foundation of knowledge as well as a doctrinal corpus of public action that weighs heavily in favour of sustainable development as a concept. The tendency has been to stress the relevance of environmental and social responsibility problems (and their necessary interlinkage), whilst convincing different actors that it is both necessary and possible to deal with them.

It is with this in mind that we can interpret the initially distinct but subsequently joined histories of the two major ingredients of sustainable development such as it is conceived today: respect for the environment and the protection of future generations’ interests; and corporate social responsibility. These two themes, with their distinct geographic, scientific and function origins, were “hybridised” (Aggeri and Godard 2006) by British consultants in the 1990s into a doctrine (Elkington 1997), conveyed for example by the WBCSD, that discusses ways of accounting for the different areas of concern. The idea here is that as long as an organisation is innovative and capable of being reformed, “being sustainable and socially responsible can be profitable” What has also come out of this at the UN and in various national environmental charters like the one France adopted in 2005 is the notion that as long as actors have enough space to interpret these principles autonomously, it makes sense to have a public policy persuading them to render their own growth (specifically their productive practices and product policies) contingent on these new constraints. In actual fact, this is one of sustainable development’s more important characteristics, to wit, it is as relevant to the managerial sphere as it is to the world of public administration. The conceit here is that sustainable development is rooted in modern regulation practices based in a form of continuity between both “worlds” that is much stronger than it used to be. This is a vision that welcomes intermediary actors like NGOs and repudiates state regulation and more generally forms of regulations in which clear and defendable objectives can be assigned to public action and imposed upon industry.

The only model put forward here is one entailing a virtuous synergy between the highly generic concerns of the three main fields in question: economic, social and environmental. This construct is an essentially idealised one built “on paper”, even if a few judiciously chosen case studies can be found amongst varying success stories to illustrate and substantiate its message. Here, economic performance is deemed congruent with an ongoing respect for social and environmental demands. This puts the market in charge of getting companies to accept their responsibilities

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- as long as consumers and investors are given maximum information on product and productive system performance. Conversely, regulatory or state constraints become superfluous or at the very least secondary. They only create norms insofar as they help with the observation of “best practices” generated by firms and decentralised experimentation alone.

What we can learn from this rapid review is that once again, innovation and substantial plausible alternatives only become doctrinally feasible when sustainable development is isolated from the more traditional development questions being asked of firms, nations and regions. In much the same way as sustainable development discourse is marked by unprecedented continuity between firms and regulatory administrations, it is clearly significant that this mainly consultant-driven ideological production has had such a strong and direct resonance in the scientific communities within which these very same consultants are operating.

Yet there is a cost to this approach to sustainable development, similar to the “all things being equal” method that a large cross-section of economic analysts apply when hypothesizing the separability of questions whose fragility has long been highlighted by a slew of authors. One problem is that sustainable development’s implicitly desired domination of other practices and/or policies is no longer feasible. In fact, the opposite occurs. In this new scenario and as is the case in a number of environment ministries, sustainable development assumes the appearance of a moral booster supplementing corporate strategies and/or public policies more than that of a force structuring them. A dream world inhabited by the kinds of synergies that are sufficiently efficient to promote an increasingly natural or self-regulated implementation of sustainable development would deprive us of the intellectual or political means to ensure these principles’ effectiveness, which in turn is a platform for their widespread support.

This stance must be transcended if we are to avoid marginalising sustainable development into the register of a discourse. The same objectives (economic progress and/or competitiveness, respect for the environment and/or future generations along with social progress) must be pursued explicitly and their satisfaction made more plausible. We can do this by producing an alternative representation of sustainable development, one that will characterised by greater realism.

Towards this end, the present project suggests five paths:

- We intend to raise sustainable development issues not on paper or by means of a few success stories but within the context of a specific activity, the automobile industry a sector characterised as one of the most environmentally fraught in Europe and across the world, even as it is driven by other considerations like jobs or the social and geographic division of labour;

- We intend to organise a hybridisation of competencies amongst sustainable development specialists who have generated knowledge during past “autonomous” social science research phases. We also want to bring in specialists on the way industrial dynamics play out in the world’s different automobile regions.

- We intend to continue the useful link between researchers on one hand, and industrial actors or policy makers on the other, a connection that has strongly influenced sustainable development research. We will benefit in this respect from the international automobile research network that GERPISA has already mobilised around this project (even if up until now sustainable development was not the main focus), i.e. some actors are already mobilised;

- We intend to integrate into this project:
  - The sustainable development interpretations being produced at different levels in the various categories of firms that comprise the automobile systems, in light of the issues that these firms themselves have been highlighting;
  - The sustainable development interpretations characterising public action such as it plays out at various levels (national, regional or global), in light of the interventions by means of which authorities try to influence automobile system structures and dynamics.

As the tender bid requires us and since we consider this appropriate, we intend to avoid highlighting only syner-
gies in our analysis of the interactional modes linking sustainable development’s different dimensions. Henceforth we will consider the need for trade-offs as being just as necessary. This will help us not only to identify which trade-offs have in fact already occurred (and possibly improve upon them) but also what kind of interaction they have with the different type of synergies considered.

Before reverting to the ties between the proposed project and existing studies on these topics, and before showing how we have structured the project into four WPs, it is necessary to specify the tenor of these principles, as well as the theoretical and empirical questions raised by research into what it means to adhere to them. This can be achieved by applying what has been said to the emblematic example of the automobile.

Recent studies ordered and then exploited by the European Commission as part of CARS 21 clearly applied the same hypotheses as we have used here. The automobile is not only a major economic and social activity in Europe but just as significant a source of environmental damage (12% of emissions of greenhouse gases). It is also the kind of laboratory that allows us to identify what transformations might become necessary in an industry that is pursuing sustainable development aims - as well as the policies required to implement such changes. The report defends two principles: the first is an analytical premise; the second a rule for action. The adoption of a holistic approach to analysis and the coordination of interventions undertaken by different departments (Competition, Environment, Enterprise, Industry, etc.) are presented here correctly as necessary not only to encourage the automobile’s sustainable development in Europe but also to implement these kinds of dynamics in other sectors.

The report seems to confirm the view we outline above. Its authors, who come from different sectors of industry or from a range of European countries or relevant national or European administrations, have juggled their own different aims and devised an accounting system that is capable, in the proposal’s own terms, of creating synergies. The great merit of their work is that it generates such synergies, although their consensus was only achieved because little was said about (or an at best expeditive analysis was made of) the different trade-offs that are required. What this means is that strategic and political problems whose resolution necessitates clear choices are not made explicit here but stated indirectly in a text that purports to consider that interactions between different dimensions are always positive ones lending themselves to the automobile’s further advance, one that will be synonymous with increased competitiveness in the European industry’s different sectors, more environmentally friendly policies, more road safety and more jobs. The question of trade-offs is truly key to most of this report. In CARS 21 this is not resolved, however, as shown by the following statement:

“‘Clean, lean and safe’ cars are not only societally desirable but they also have the potential to create a competitive advantage for the industry, insofar as they meet these consumer expectations, are affordable and address needs which are applicable to, and have to be addressed by, the global community as a whole. CARS 21 stakeholders therefore find it important that European standards are being adopted in other markets and would encourage this trend.’”(CARS 21 Final Report p.16)

Three dimensions of sustainability are distinguished in the new framework: ecological sustainability, social sustainability, and economic sustainability. We can easily recognize these three dimensions, for instance, in the CARS 21 report. The report formulates recommendations for a better regulation that include the ecological dimension (objective to reduce emissions), the social dimension (objective to increase road safety), and the economic dimension (objective to improve competitiveness of the automobile industry).

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2) Some of us have already worked on the preparation or conclusion of these reports: U. Jurgens was one of the experts consulted by the ‘high level group’ to prepare their report; B. Jullien was appointed as an expert by a working group set up by the European Economic and Social Council to examine the lessons that the Commission drew from the report.

The public debate and the research about sustainable development issues related to the automobile and to mobility show that there are (at least potential) trade-offs between these dimensions and that it is not simple to achieve synergies. The long debate between those who see ecological regulation as a job killer and those who stress its employment-creation potential is the best known example of trade-offs and synergies. The relation between ecological innovation and employment is an important but not the only arena of trade-offs and synergies. If we take the ecological sustainability as the starting point, we can see several areas of potential trade-offs or synergies:

- Ecological innovation - employment: Technological innovations aiming at improving ecological sustainability have effects on the value chain and can cause employment losses in some parts of the automobile industry and in other industries linked to automobile production. However, they can also create new products and employment (e.g. fuel cell). Cross-industry effects have to be taken into consideration. The change to regenerative fuels creates new growth opportunities for agriculture in both industrialized and developing countries but it implies also some dangers (e.g. negative social effects through increasing corn prices).

- Ecological innovation - regional development: Ecological innovations can change the competences required in the development and production of automobiles and cause a restructuring of value chains and automobile production regions. Do traditional automobile regions profit from the orientation on ecological sustainability due to their technological capabilities? How can regional policy create synergies between ecological innovation and regional development?

- Ecological innovation - innovation costs: Ecological innovations require high investment and high innovation capability as well of OEMs as of suppliers. It is an important question if the OEM-supplier networks support such innovations and if the power-asymmetries and the cost pressure of OEMs on suppliers does not represent an innovation barrier. OEMs can shift the burden of innovation costs to suppliers or they can develop a more cooperative division of labor.

- Ecological innovation - consumers’ demand: The ecological sustainability can collide with the consumers’ preferences for size, speed and price (SUVs and premium cars on the one hand, and low-cost vehicles on the other hand), though there are activities for and signs of a change of preferences. Thus, the companies have to solve conflicts between ecological goals and product policy requirements. They can choose an active approach aiming at developing new markets or remain passive.

- Ecological innovation - functional requirements: The ecological goal of emission reduction (e.g. use of light materials, reduction of weight) can collide with the requirements for safety. However, there are also potential synergies. The development of sensors and electronics pushed by safety regulation can also help in the development of ecological innovations.

- Ecological innovation - relocation and international division of labor: Since the 1990s, there is an intense discussion about the relocation of production from industrialized countries (Western Europe, USA) to low-wage countries (Eastern Europe, China). The costs of ecological innovation can increase cost pressure and relocation to low-wage countries. Another aspect is the development of competences needed for “green” cars: Will the traditional industrialized regions profit from their technological experiences and will the newly industrializing countries develop the competences needed for ecological sustainable products? Ecological regulation in the Triad countries has also the effect of raising market entry barriers for car producers from LCC-countries like China or India which do not have the required technological capabilities. How will the producers outside the Triad react?

Even if this list does not provide an exhaustive overview on all areas of trade-offs or synergies related to sustainable development in the automobile industry, it shows that most of them have a complex character and (with a few exceptions) cannot be reduced to technological problems. Actually, actors in the automobile industry are confronted with a variety of trade-offs within companies, within the industry, and
between different industries, which they have to manage concurrently and (in the best case) turn into synergies. They do this on the basis of given company productive models which are the results of the trajectories of the companies in the past. Product technology issues have to be seen in relation to product policy, supply chain, labor and financing issues in order to get a comprehensive view of the trade-off and synergy problematic. The interaction of different processes means that the solution to one particular trade-offs can produce new conflicts and problems in another area, thus generating a fragile process of readjustment and the on-going formulation of compromises.

So, clearly trade-offs will have to be made. Firms will do this, each probably in its own manner. Public policies will have to be coordinated as ranked objectives that will influence these trade-offs in a way specified by this hierarchy. To achieve our purposes, it will be necessary to take a deeper look at the trade-offs identified in such cases, in relationship to the synergies that could either be implied by them or arise from them. This is the purpose behind the present proposal and the goal of our research.

**Progress beyond the State of the Art**

 Until the end of the 1990s, the literature on sustainable development exhibited a clear tendency to detach environmental questions and the issues related to the corporate social responsibility from the other key influencing factors on the dynamics of firms and industries. The past ten years, however, have seen greater theoretical and operational convergence, as the limits of this position have become more apparent. The subordination of corporate management to more stringent environmental requirements and the development of socially responsible organisations was explicitly formulated in 1997 by Elkington in the introduction to “The Triple Bottom Line of 21st Century Business” in which it is claimed that “it can be profitable to be a sustainable and socially responsible firm”. During this past decade, managers, public policy makers and researchers have been drawn towards a common goal to identify and foster the innovations and/or the conditions under which these synergies can be achieved (Godard 1994).

In essence, the prevailing viewpoint is that these conditions remain to be unearthed by the actors through both innovation and experimentation. This has had two major consequences at the research level:

1. At firm level, most of the research has been based on case studies proving that this virtuous circle could be in fact attainable and implying therefore that there were good “rational” reasons to push or to persuade corporate managers in this direction. As a result, managers were expected to adapt their perception of environmental and societal pressures as threats, and to start seeing them as opportunities to differentiate their corporate policy and guarantee their financial results. For the firms engaged on these new paths of growth, therefore, regulations resulting from environmental and CSR concerns would no longer be perceived as obstacles and would support the development of their “virtuous” strategies.
2. At the level of public policies and regulation, fundamental change in the forms of regulation of economic activity was also expected from the necessity for renewal in order to create the right conditions for sustainable development. It was argued that new forms of innovation were required and that these were, by definition, difficult to translate into “civic regulation” (Vogel 2005) as the “traditional forms of state regulation” had become obsolete. It was not believed that public policy could deal efficiently with the new social and corporate demands for institutional innovations, whether they were taking the shape ‘of new demands of consumers for ethic products’, ‘social movements (boycotts, militant actions by NGO)’, ‘pressures from investors who want to be socially responsible’ or ‘the assertion of values brought forward by managers and employees’ (Aggeri and Godard 2006). As public policy makers are too removed from economic action, it was argued that public policy itself required major changes, for example with the establishment of ‘hybrid forums’ (Callon et al. 2001) where it would be possible to bring out the ‘best practices’, and, if necessary, the rules and the norms
needed to foster the changes implied by the imperatives for sustainable development.

By 2007, the research output developed under these two perspectives had grown significantly and the response both from managers and public policy makers was largely positive. They have contributed to the political success of sustainable development. Sustainable development in general, and in the automobile industry in particular, has become one of the strategic priorities of firms, whether they are OEMs, suppliers, distributors or after-sale suppliers. Sustainable development has also acquired a dominant status in the framework for public policy making at different European levels and worldwide. The pertinent research question today is to consider how these principles can be applied on a larger scale to cover an entire sector of activity and not only the practices of a few pioneering firms. When implemented at the level of an entire industry sector, sustainable development becomes a new paradigm that is able to structure the productive logics of industry actors and the regulations that apply to them.

It is precisely in these terms that the report CARS 21 is defined and the consequences drawn from this report by the European Commission in their statement of 7 February 2007 further underline the importance of this sectoral approach. In order to entrench the principles of sustainable development into a general system of regulation and a shared framework by industry actors, it is obvious that research on questions relating to issues of sustainability needs to be closely linked to a deep insight into broad sectoral concerns yet this is not yet the case in much of the specialist literature on the topic.

Therefore, when we seek to do more than to highlight few exemplary cases, and wish to portray sustainable development either as a general system of regulation or a shared system of reference, the research undertaken must also progress beyond the principle of separation that is still evident in much of today’s specialist literature. What both firms and policy makers need is an understanding of practices of social responsibility that is not removed from an understanding of the dynamics of the industry in question and the specific concerns of different actors. This involves identifying not only when actors manage to develop the positive synergies looked for but also identifying the times when the actors are unable to generate them and they are forced to make trade-offs between conflicting priorities.

The underlying hypothesis of our work is that firms involved at the different levels of the value chain are primarily concerned with the economic sustainability of their strategies. In order to identify the transformation in these firms’ economic, managerial, technological and commercial rationales that occurs when they adopt a framework of sustainable development, it is first necessary to understand their initial strategies and trajectories.

Similarly, public policies that regulate the automobile sector have pre-existing purposes and the forms of intervention used have developed progressively over the years. The new framework and measures required to promote sustainable development will not “naturally” fit into the existing set of processes and procedures. Therefore, as suggested by the few examples of trade-offs highlighted above, the concept of trade-off has to become at least as important in the research process the notion of synergy has been to date.

Our goal is to integrate the findings of the work conducted in social sciences on sustainable development with the research carried out in the same period in the automobile industry. Neither approach will dominate but we believe that previous advances in understanding gained from our work conducted on the automobile industry will permit the development of a sector-specific framework for sustainable development. In the automobile industry, more than in any other sector, it is our firm conviction that “history matters”. Subsequently, the capability of the different actors involved in this industry to integrate the sustainable development orientation into their individual trajectories continues to be strongly influenced and shaped by other considerations. It is our appreciation of this interdependence that will allow us to understand why and how they can or cannot achieve the different levels of synergies potentially achievable by integrat-

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ing the sustainable development framework.

For example, the work of Aggeri et al. (2005) on a limited sample of enterprises who are pioneers in the area of sustainable development highlights the fact that these companies, before even making explicit reference to this concept, had to face a series of problems related to different forms of pollution generated by their installations. Unlike other firms, they had proactively developed technical and social solutions (involving, for example, consultations with local communities) to these problems, which have allowed them later to assert - rather than endure - their social responsibility. As a result, each of the cases studied (the cement manufacturer Lafarge, the steel manufacturer Arcelor, the hotel group Accor and the distributor Monoprix) exhibits quite different forms of interpretation of the concept of sustainable development. Similar work, albeit from a more theoretical perspective, has been carried out by Oltra and Saint-Jean (2006) on the development of clean technologies in the automobile industry. Their models are based on the concepts of evolutionist theories of technical change and they consider that the learning achieved by these firms occurs on the basis of what they have learned to do in the past (path dependency) and convergence did not occur between them even when they are subjected to a common set of new constraints.

On Corporate Social Responsibility, the GERPISA project aims at developing a critical interdisciplinary perspective. CSR (Ruggie 2004) is a concept which gains in importance and is taken up by institutions and actors like the EU, the OECD or the UN. But at the same time, authors like Heckscher et al. (2003) claim that what we are currently witnessing is a fundamental break with the post-war governance regime and point to conflicts that lurk beyond the discourse of CSR: “what is happening now is the dissolution of the existing stakeholder regime under the pressures of new actors and economic forces.” In this respect, the question raised is to what extent the development of CSR carries the synergies expected, or covers the emergence of new trade-offs. On the other hand, the approach developed by Daugareilh, which adds a legal perspective to the research on CSR, questions, in line with other studies (Hommel 2006) what is truly novel in the regulation practices that are connected to the generalisation of CSR concepts. By linking ‘hybrid forums’ and the other “open arenas” to the generally accepted principle in Labour Law of a plurality of sources of law, this critical approach allows more rigorous evaluation of the degree of novelty that most of the references to CSR appear to imply. More important, it shows, as was already the case in the research work done on the plurality of sources of law, that the constraints placed on the different actors and the balance of power at work can vary significantly, even when the reference is made to the same set of rules (Daugareilh 2005).

The work and concepts developed by the international network GERPISA over the last 15 years, and which have structured the activity of its four consecutive international programmes, also indicate the extent to which the automobile industry is characterised by a great degree of variety, both in terms of strategies and organisations. Whether at the level of the internationalisation process, or at those related to technology, human resources and innovation management, the different international programmes of GERPISA have demonstrated that the idea of a ‘one best way’ is historically untrue and theoretically doubtful. At the same time, by relying on the concept of the productive model (Boyer and Freyssenet 2002) introduced during the first international programme, GERPISA has developed and diffused a theoretical framework which does not reduce the analysis of this variety to the sociography of single cases, but tries to grasp and explain how, in the automobile industry, this historically limited diversity of productive models is constantly organised and renewed. This has been connected in particular, both theoretically and empirically, to the diversity of macro-economic conditions under which the actors of the automobile industry have to perform, and to the variety of the internal compromises of government which emerge in this process. For example, the carmakers Toyota and Honda, both operating under the same macro-economic conditions, actually rely on quite distinctive productive models (Freyssenet et al. 1998). The first model refers to a strategy of “permanent reduction of cost at constant volumes” and the second to a strategy of “innovation and flexibility”. They do not implement the same type of employment relationship,
nor do they have the same type of organisation of their suppliers or the same product policies. Yet they have both achieved the internal and external coherence necessary to make of these companies two viable and prosperous actors in the automobile industry.

This approach was developed on the basis of the research work conducted for the first programme called ‘emergency of new industrial models’ and carried-out between 1993 and 1996. It has constituted a major theoretical reaction to the propositions of the International Motor Vehicle Program (IMVP) of MIT, whose coordinators, Womack, Jones and Roos had published in 1990 “The Machine that Changed the World”, a well know and very influential book. This work claimed that no carmaker would be able to survive the 1990s without wholly implementing the principles of lean production, which were based on Japanese practices, and were supposed to become the “one best way” for the automobile industry (and beyond) in the 21st century in the same way as the principles of mass production had developed in the 20th century. The research output developed initially was integrated into the productive models approach by GERPISA and researchers have thus shown that, as it was already the case throughout the 20th century, there was not a “one best way” emerging from the analysis of the recent period. Moreover, the approach underlined that this diversity was not only necessary but also desirable both economically and socially: firstly because a part of the sustainability of each model is related to the fact that is differentiated from those which characterise its competitors, and secondly, because the capability of the industry as a whole to find ways to adapt to new conditions is strongly increased by this diversity.

While IMVP, in carrying on their research on questions also addressed by GERPISA, persisted in their quest for a “one best way” towards which the search for efficiency would compel the industry to converge, the other international programmes of GERPISA have built on the results of the first programme to integrate other dimensions of industrial activity. These cover the forms of internationalisation of design, production and product policies, and, in the CoCKEAS programme financed in the FP5 framework, the modes of coordination of competences and knowledge in the European automobile systems. In both cases, it emerged that the forms of internationalisation and the forms of innovative activity on the part of the firms studied and of their partners did not adhere to the thesis of growing convergence.

More recently, under the ESEMK programme financed by EU’s FP6, GERPISA researchers have focused their attention on the micro - meso - macro conditions of viability of productive models not only in the automobile industry, but also in other sectors, in order to assess the structural linkages between the industrial performance at the micro level, and the performance of different types of capitalism at the national macro level. In analysing how employment relationships are changing in an enlarged Europe, and by increasing the stress both on the commercial practices and on the relationships that take shape between the firms and the regulations which apply to them, the research output in this fourth international programme highlights once again the ongoing renewal of diversity of the practices studied. This diversity emerges at different levels, between the variety of contexts and the different forms of national regulations in which the enterprises operate, between the path dependencies embedded in the trajectory of these firms and the new challenges that they have to take on, and between the crisis or the evolutions of the national political compromises and the search for viable compromises of governance at the enterprise level.

For example, the study carried out by the researchers of WZH on the manner in which the “German model” or the “Swedish model” are exported in the countries which have recently entered the European Union, shows that neither the reference to a specific national context, nor the fact of belonging to a same industry and/or even to a same firm, can explain how the employment relationship is articulated at each production site. Internationalisation does not emerge as a factor for homogenisation, but rather as a process where the structural diversity of the car industry is constantly renewed. The same logic applies to the impact of European competition law on the dynamics of the automobile sector, and in particular at the level of distribution, which has been another important object of research for the ESEMK project. A great level of variety remains in the way European carmakers conceive and manage their interests, which explain
why the attempts of the European Commission to force the sector towards new forms of distribution have been largely frustrated to date. There are of course lessons that can be taken from these analyses of the fundamental distinctive dynamics which characterise the different actors of the European automobile industry, in particular at the level of policy making. Attempts to force these actors towards a desirable unique model - the lean distribution for example - were inevitably thwarted by the structural variety of the productive models involved and by the specific needs of each to guarantee their economic survival. A more nuanced approach aimed at introducing the relevant desirable practices within different models would appear to offer greater chances of success.

These insights appear particularly useful once applied to the question of sustainable development and desire, at policy making level, for an industry wide convergence towards this new organisational model, as expressed in the CARS 21 report. It is clear since the beginning of the 2000s that all the firms involved in the automobile industry have recognised the need to reform their practices in order to adhere to a framework more in line with that of sustainable development. For many observers, this credo appears as the logical replacement of many others that have previously defined the point of expected convergence for this industry, such as lean production fifteen years ago, the globalisation of the automobile industry and the need to manufacture at least 4 million vehicles to survive ten years ago, or, more recently, the necessity for the industry to adopt the practices of a knowledge based society in order to maximise their innovative capabilities. The scientific approach of GERPISA to analyse this supposed convergence towards sustainable development will thus be built on the line of what has been achieved in the previous programmes. It will focus on the concrete reality of public policies and of company practices in terms of sustainable development, at the micro, meso and macro levels, in different national contexts and within the trajectory of each major actor of the industry. It will structure, in analytical terms, the variety of the macro-economic and socio-political contexts on the one hand, and the variety of the company trajectories on the other, based on the underlying hypothesis that it is at the junction of these two dimensions that actors try to achieve the desired synergies in terms of sustainable development but also make the inevitable trade offs under the on-going constraints of their economic activities.

Our ambition is therefore to integrate in a single scientific approach the social, environmental and economic dimensions at the core of the development of the automobile industry today. Our work will be organised in two main axes:

- The first research axis focuses on the practices of the firms and its objective is to determine how their trajectories have been affected by the integration of the new environmental and social stakes embodied by the concepts of sustainable development and corporate social responsibility. More specifically, we will try to characterise how the main actors of the industry (at the different levels of the value chain) interpret these common references and translate them into concrete practices. For this purpose we will rely on:
  - The research output on the trajectories of the firms already published, which will be largely updated at the 15th International Colloquium of GERPISA to include in detail the developments of the last ten-fifteen years;
  - The research work on design and innovation and in particular the research conducted by the CGS (Armines) on new paradigms of innovative design (Hatchuel et al. 2006);
  - The research on the supplier industry and on the new forms of division of labour in production and design identified in the debates on the question of modularity (Frigant 2005; Jullien and Jurgens 2006);
  - The research on distribution, repair and automobile services, which stress the need to integrate these actors and the role they play in the management of innovation in the research agenda (Ballot et al. 2006; Jullien 2006).
- The second research axis focuses on the political, economic and social contexts in which the firms have to define their strategies and develop their own concrete interpretations of this new framework.
  - For this purpose we will rely on:

5) A new collective book which will be published in 2008
- The research work on the variety of capitalisms (Amable 2003) which expands on the theoretical and empirical effort made during the ESEMK (FP6) programme and tries to characterise how these configurations are translated at the meso economic level into the structure of the automobile systems, considered as both systems of production and systems of use;

- The research work produced by the research of historians, sociologists, economists and political scientists on the “politics of industries”, which tries to understand how a political order emerges in a sector which has multi-level configurations as regional politics - European in particular - have to be integrated with national and international forms of regulation.

- The work of researchers directly involved in the study of the different dimensions of sustainable development and in particular those concerned with the production of environmental norms and their effects on the development of new technologies (Oltra and Saint-Jean 2006), and with Social Corporate Responsibility and its relationship to the regulatory devices already in place and which continue to be used by the actors (Daugareilh 2006).

The GERPISA project aims to take a holistic approach to the issues to be investigated. All the interactions that link the economic, social and environmental dimensions of the development of the European automobile industries will be taken into consideration. These interactions will be considered both from the perspective of the companies involved in the automobile industry and from the perspective of the policy makers whose decisions influence the industry. The project will thus lead to the creation of a typology of possible forms of interaction. The purpose of this typology is twofold. On the one hand, it will be of interest to different stakeholders involved in the industry for the purposes of dialogue and debate on key issues and it will help them to evaluate alternatives more clearly. On the other hand, it will allow for identification and analysis of key synergies and trade-offs to facilitate comparison with the emergence and adoption of sustainable development practices in other industries that have also needed to adapt.

Methodology and Associated Work Plan

As the methodology for addressing the research questions raised is intensely time consuming, a certain number of key interactions will be selected and to be examined in great detail. This selection will be the objective of the first Work Package (WP1), outlined below. The primary focus of the research undertaken will be the synergies and trade-offs within a European context and their comparison with other regions. The in-depth studies of similar synergies and trade-offs in a US, Japanese, Chinese and Indian context will be conducted within the international GERPISA network whose research programme for 2008-2010 will be structured to reflect the same themes as those outlined in this project.

Within this framework, the research work will be structured around two main axes. The first will consider how positive synergies and negative trade-offs related to sustainable development emerge at firm level with specific attention paid to interfirm relations, where many of these interactions occur. This will be the objective of WP2. The second axis will examine the macro-economic environment and the broader political, social and institutional framework and the public policies that have an impact on the development of automobile systems, regardless of whether or not these were explicitly referring to sustainable development. This is the objective of WP3. By combining these two research axes, we will subsequently analyse how the automobile system in Europe is evolving in a way that will favour sustainable development. WP4 will thus address the dual objective presented in the conclusion of the previous section to identify best practices in decision-making on the part of both firms and policy makers.

WP1 - Development of Hypotheses and Selection of Key Synergies and Trade-offs and Case Studies

The objectives of WP1 are:

1. To study each main dimension of the sustainability of the development of the automobile industry as they have been traditionally defined and as they are interpreted today;
2. To identify precisely a collection of trade-offs and synergies linking these dimensions and to select some of them as the core agenda of future research;
3. To build the analytical framework that will be applied in WP2 and WP3 to examine the positive and negative interactions between the different dimensions of sustainable development in the automobile industry;
4. To translate this framework into research hypothesis and into a research agenda for the different tasks defined within WP2 and WP3.

Concerning the first objective, four major themes will be examined in detail and, for each, a detailed bibliography will be created and interviews will be conducted with industry specialists. The research team will thus develop in-depth understanding of the questions facing the industry and the manner in which firms and policy makers have been addressing them.

These four themes are:
- The environmental impact of automobiles both ‘in use’ and at ‘end of life’
- The social responsibility of automobile firms with respect to their employees, their subcontractors and their distribution and repair channels
- The competitiveness of the European automobile industry
- Road safety

Four international and interdisciplinary task forces will be created to examine these four key themes in detail. This analysis will cover the academic literature available on the topic and the major studies and reports that have been commissioned over the past fifty years in response to public policy makers desire to address the issues involved. This phase will involve diffusing the work done already by many members of the research consortium on these issues and ensuring that each of them has been researched in detail.

So, WP1 will firstly address the following questions:
- When and how did these questions emerge and how have they been addressed? How have firms acted or reacted in relation to them in different European countries, at the level of the European Union and beyond?
- What questions are generating heated debate in 2008?
- How does each theme relate to the other three themes being examined?

The second part of the research of WP1 is
- The iterative design of a common analytical framework by the coordinator and the steering committee on the basis of the state of the art and of intense exchanges with the members of the consortium,
- The definition of research hypotheses and research methods by the teams involved in WP2 and WP3. It will involve a preliminary enquiry to verify that the synergies and trade-offs to be examined are, in fact, believed to be of critical importance and to guarantee that the research teams will have access to data and key actors for their empirical work.

Then GERPISA will produce:
- A set of four reports about the topics selected
- A summary of the current situation of the European automobile industry in relation to sustainable development, covering the main trade-offs to be made and/or synergies to be developed by both firms and policy makers.
- A specification of the common framework and definitions of the research agendas to be implemented for both research axes whose programmes will be then defined clearly by the co-ordinators of WP2 and WP3.

**WP2: Firm-level Analysis of SD Related Tradeoffs and Synergies in the Automobile Industry**

The aim of the WP2 will be to analyze trade-offs and synergies related to issues of “sustainable development” at the level of firms. The configurations of trade-offs and synergies are influenced by regulatory contexts, company trajectories and strategies, and factors linked to innovation dynamics. Thus there are considerable differences for instance in how firms in Europe, the U.S., Japan, Brazil, China and India deal with the trade-offs and synergies of sustainable development. For instance even within Europe recently, companies have followed different approaches (e.g. the difference between German and French producers with respect to the Diesel filters).

There are a large number of studies on the issue of sustainable development at the company level (“greening business”). These include economist approaches dealing with
the possibilities to internalize the costs of ecological damage, analyses of conditions for success of ecological products (e.g. the “strategic niche management”) (Kemp et al. 1998), studies about the “greening” of particular company functions like marketing or supply chain management (Preuss 2005), studies about organizational cultures and their effects on the capability of companies to adapt to sustainable development (Hard and Knie 2001) or studies stressing the role of pioneering companies and isomorphism in “greening business” (Aggeri et al. 2005). There are also many studies about ecological innovations in the automobile industry. Most of them have a very narrow focus on particular products or technologies, however. Within this context, there are studies which analyze the employment effects of “green” innovation and there is a long debate about trade-offs between ecological requirements and employment (Brett and Smith 2001; Meisser 2005; Ziegler and Zwick 2004).

Despite this broad discussion, however, there are only a limited number of studies that link the study of sustainable development at the company level with the analysis of industry dynamics and company trajectories which shape the options for action available to companies and other actors. Such an integrated approach will be undertaken in WP2. WP2 will provide studies from three perspectives on sustainable development at the company level:

- Studies of company trajectories, which analyze trade-offs and synergies of sustainable development within the organizational context of one company,
- Studies of innovation trajectories, which analyze trade-offs and synergies of sustainable development from the perspective of particular innovations and large ensembles of companies and other actors,
- Studies of the issue of social sustainability and Corporate Social Responsibility.

The first strand of research will provide studies of company trajectories, in particular for car manufacturers. Company trajectories evolve from strategies, events and framework conditions in the history of companies, and include in particular specific product policies, productive organization and labor relations. The industrial models resulting from these trajectories limit the strategic options of actors in the companies. Synergies and trade-offs between environmental dimensions and the product policy and productive organization of the firms will be at the heart of the analysis. We will analyze whether the trajectories have led to path dependent structures and strategies regarding sustainability or if, and in which situations and constellations, new path creation is possible. While this research focuses primarily on the leading OEMs, an important aspect will be the role of alliances between companies. Alliances between different OEMs and between OEMs and key suppliers have become an important element of innovation strategies related to issues of sustainable development (for instance, in the area of hybrid cars). Besides car makers, company case studies will also be conducted on selected suppliers of product or process technologies and, in view of the crucial importance of emissions, on fuel producing companies, carbon-based or alternative.

Another important issue in order to link the research in WP2 to WP3 will be the demands formulated by companies and the influence of automobile companies on public regulation. Another question will be the relationship between the “sustainable development” narratives developed by firms and their actual practices in terms of product policies, productive organization, employment, and supplier relations.

The second strand of the WP2 will be the analysis of innovation dynamics within and between firms related to sustainable development. The research will focus on trade-offs and synergies linked to important innovation fields in the automobile industry. WP2 will take a “process view” on configurations and chains of trade-offs and synergies. The “process” view allows us to investigate the interaction between different trade-offs or synergies and analyze how the solution for a particular trade-off can produce new trade-offs in another domain. The research interest here is on gaining a deeper understanding of the dynamics of trade-off and synergy processes and transformations of one into the other.

The research will go beyond simple one to one tradeoff-relationships between sustainability goals. Rather we are interested in more complex relationships such as, for example, between innovations in the area of safety and of emis-
sions thereby relating different aspects of sustainability. Product technology issues will have to be seen in relation to product policy, supply chain, labor and financing issues in order to get a comprehensive view of the trade-off and synergy problematic. One approach for the analysis of innovation trajectories will be the “innovation biography”.

An important point will be to analyse the relationship between “green” innovations and the cost competitiveness requirements in the industry. This concerns first the classical debate whether ecological innovations are job killers or job creators. But there are also other issues. OEMs use cost pressure on suppliers and the relocation of production to low-wage countries as instruments to safeguard cost competitiveness of their products. How does the cost pressure on suppliers affect their innovation capabilities related to sustainable development? How does “green” innovation influence the division of labour between high-wage and low-wage countries? Can the emerging markets become the laboratory for new innovations (e.g. Brazil and its ethanol cars)? What will be the sustainability implications of the current wave of low cost cars?

The third strand of research within the WP2 will deal with issues of social sustainability and of corporate social responsibility (CSR). The European Commission has identified CSR as a contribution of business companies to the goals declared at the Lisbon summit and has expressed interest in the evaluation of CSR activities. There is, however, no consensual definition of CSR, a broad range of different firm practices and a lot of issues which are subsumed under CSR starting with ecology and ending with corporate citizenship. Within the scientific discourse, there is considerable dissatisfaction with the strong normative overtones of the concept and with its vagueness (Crouch 2006). Within firms, CSR remains an issue of controversy and uncertainty. The elements and the impacts of CSR are far from clear as it is a voluntary concept on the one hand and on the other hand a concept which is supported by political actors and increasingly monitored by financial markets. Many rating agencies have emerged which evaluate the performance and policy directions of companies vis-a-vis sustainable development and corporate social responsibility goals. Capital market actors and institutions play an increasingly important role in influencing the specific trade-off/synergy calculations.

WP2 research will take particular account of stakeholder interests from the side of the employees and the trade unions (sometimes called “stakeholder dialogue”), suppliers, and of the regions and municipalities where firms are located. All these stakeholders are becoming increasingly concerned about the threat of relocation of production and about competition from low-wage countries. The research will investigate the impact of company decisions on trade-offs and synergies regarding sustainable development on employment levels and management-employee relations as well as on the relations with regional suppliers. It will pay particular attention to the role of CSR in the debate about relocation from high-wage to low-wage countries. Does CSR have much to offer to industrial workers in advanced industrial countries, as the frame of reference shifts away from the nation-state towards regions or the “global arena” (Ruggie 2003) In what ways are companies dealing with issues of employment protection and of monitoring work standards in supplier companies in their CSR policies.

**WP3: Policy Makers-level Analysis of Synergies and Trade-offs of ‘Sustainable Development’**

Even if both managers and administrators responsible for regulating the automobile industry willingly adhere to the sustainable development framework, policies which directly or indirectly, explicitly or implicitly intend to promote sustainable development in the automobile industry cannot be solely derived from the interests of firms or from what their entry into the new framework may lead them to develop in terms of discourse and practices. It is for this reason, in parallel to the ongoing work of WP2, that another WP will study the impact of public policies on industry life, its tradeoffs and/or synergies that are at the origin of interpretations of the sustainable development framework. To accomplish this goal we need to investigate the different dimensions involved in a holistic approach that integrates environmental, social and economic objectives in the development of the automobile industry. For this reason the WP3 can not confine itself to measures that are exclusively concerned...
with sustainable development. This study will therefore seek:

1. To understand how the complex set of rules which regulate the development of the automobile industry is constituted.

2. To evaluate if and in what way this complex produces synergies and/or trade-offs that makes sustainable development possible.

To grasp the ensemble of these rules fully and to appreciate their variation from one country to another within the European Union and from one world region to another, it is imperative to define from the start how automobile systems are structured and differentiated in relation to their macroeconomic, social and political context. It is clear, in fact, that debates of a seemingly technical nature like those surrounding the ‘pedestrian directive’ or acceptable emission limits involve high stakes for automotive makers and their ability to defend their relative competitiveness. These stakes relate directly to the systems of production and differentiated automobile usages whose structures and transformations may only be understood with reference to the economic, social and institutional configurations in which these systems emerge.

Therefore, in order to determine which modes of interpretation of sustainable development characterize different national and regional configurations within Europe and in the other two regions of the Triad or in emerging automotive markets, one must understand that the very notion of automobile and its broader implications does not have at all the same meaning from the perspective of all the different stakeholders. Thus scholars have recently argued that the opposition between manufacturing and non-manufacturing countries constitutes a major key to understanding other European debates, such as the application of competition laws to automobile distribution (Pardi 2006). Moreover, with respect to debates over environmental norms, the characteristics of national or “regional” automobile markets play a critical role in the staking out of positions and, therefore, the outcomes of debates.

In order to comprehend the automobile industry as the aggregate of business activity, markets, and employment and how these systems evolve in greater or lesser convergence, this work will first attempt to link the evolution of these systems to economic and institutional trajectories on the national and regional level. It will be possible to rely on previous research for this purpose. Indeed, an analysis of productive models and their evolution will make it possible to identify the conditions of compatibility between product strategies, production organizations, and labor relations within the sector of auto makers on the one hand and the modes of growth and the distribution of revenue of national economies on the other (Boyer and Freyssenet 2002). An analysis of the systems of automobile usage or of “automobility” will provide here additional insight by adopting a perspective focused on automobile demand. This analysis will make it possible to understand the economic and social relations that households and private companies have with automobile products (and services) and the structure of business opportunities that present themselves to automobile professionals.

In parallel with the first task of the project, WP3 will investigate the policies of the automobile industry and how they are structured and restructured on national and regional levels (Jullien and Smith 2005a, 2005b). In this case we will rely on a approach of political analysis informed by the work of historians (Ramirez 2006). These policies, tied as they are to automotive manufacturing, relate back to productive strategies as well as to the logic and doctrines that define the different institutional environments. These include property rights, automotive fiscal systems, infrastructure policies, and international commerce. Whether explicitly or implicitly, these automotive policies influence trade-offs and potentially produce synergies, it becomes therefore useful to ask if they have been reevaluated and/or revised under the pressure represented by the rise of sustainable development as a new framework of reference.

In developing this perspective, reference will be made to both historical and political analyses. The role of the State in the development of the automobile industry during the last century has been indeed clearly stressed by the works of historians (Bardou et al. 1982), for example at the level of public investment, fiscal policy and the deployment of commercial and technical barriers. It is in order to better understand
these interactions that a group of young researchers have come together to form the working group SAPAI (State And Politics in the Automobile Industry) in 2004 within the GERPISA (Pardi 2007). In a similar perspective, the works of the political scientist A. Smith and economist B. Jullien aim at investigating the problems of industrial organizations and the politics of industry. For this purpose they have conceived and tested an analytical framework that distinguishes four large series of regulations that structure the life of automobile industry: their role is to stabilize the relations that industry firms form with financial institutions, employees, suppliers and customers by establishing what have been defined as “instituted relations” (Jullien and Smith 2008).

The questions raised by this framework are:

1. How were these relations structured and differentiated in Europe and in other regions of the world in accordance to the historical evolution of policies aimed at regulating the development of the industry in particular, commercial (Customs Law, Property Law), fiscal, trade, and infrastructure policies, and also road transportation safety;
2. Whether if or how the new objectives and procedures associated with the new sustainable development framework have an impact on the restructuring of these relations.

So far we have researched the political and economic context of these policies and identified the trade offs associated with them. In WP3 we move to the final stage of analysis, which will concentrate on those policies explicitly conceived to promote sustainable development in the automobile industry and their associated synergies and/or the trade offs.

From this perspective, the consequences drawn from the different administrative levels of the necessity to improve transportation safety and environmental policy will be privileged and studied both from their genesis and in their impact on different industry stakeholders. To this end, then, the skills of historians, sociologists, legal scholars, and environmental economists will be brought to bear in Task 3.

More precisely, the purpose of the study is to evaluate if and to what extent the integrated approach reforms regulations which have traditionally been applied to the automobile industry in a few key domains. In fact, even if the “new guiding principle” carries the hope of tying together all these dimensions, they continue to be the object of what political scientists call “sectorial policies” (Muller 2003). Leaning on administrations and specialized expertise, this sectorization, which in many cases has existed for a long time, continues to prevail and justify itself by the complexity of the questions posed by each of the dimensions themselves and the related necessity of developing a highly specialized expertise required to document decisions. A number of GERPISA researchers are specialists in understanding sectoral policies. For example, the historian, M. Moguen has analyzed how policies aiming to reduce automobile fatalities have been structured in Europe. Another example is how industrial economists from GREThA have developed for several years a common approach to understand how different types of norms are more or less adapted to contribute to the development of clean technologies. Finally, the legal scholar I. Daugareilh examines the question of CSR by attempting to measure and situate this novelty as a tool for social regulation.

In the three approaches proposed, the necessity to integrate all the interactions is obvious in order to resolve the problems that are being addressed. The question of vehicle safety, for example, is thus incomprehensible without taking into account the industrial constraints and the functions and powers of the relevant public authorities, on the one hand, and the need to convince all parties of the compatibility between the measures taken and the preservation, if not the improvement of relative competitive positions for automotive makers on the other (Moguen 2007).

To approach these sets of issues from another perspective, Oltra and Saint Jean’s research (2005a, 2005b) demonstrates that in order for firms to adopt clean technology, it must combine environmental performance with productive efficiency (in terms of productivity and cost). Indeed, clean technology must also be competitive when compared to conventional technologies on non-environmental criteria. This means that both objectives should be considered simultaneously, in particular for radically new clean technologies that may exert disruptive effects on prevailing processes and products. Clean technology must lead in the short term to
more efficient and to cleaner production in order to benefit from “win-win” effects as described by Porter and Van der Linde (1995).

By bringing together all of competencies in Task 3 of WP3 it will be possible to determine the degree of potential fruitfulness of the new guiding principle in helping to make trade-offs more effective today.

**WP4 - Synthesis and Political Implications**

Over the past decade, sustainable development has become associated with the adoption of a new framework. This framework has obliged public and private actors to develop and justify their activities simultaneously along three dimensions: social, environmental and economic. As they are seeking to make compatible objectives that may appear contradictory, the actors encounter difficulties in developing their activities under this new regime. This, in turn, requires us to pay particular attention to the analytical dyad of synergies and trade-offs. We are as interested in the manner in which actors make their choices as in the outcome of the final decisions. In studying how the practices of automobile firms have been renewed by this sustainable development framework, it is crucial to identify the forms of innovation and the types of organisation that will generate positive synergies. Similarly, in relation to the development of public policy, it is as important to understand the procedures and the tools used to build the norms, rules and practices as it is to understand their outcomes. With this in mind, WP4 will provide a synthesis and integration of the research work conducted in WP2 and WP3 and will address both perspectives.

The first perspective will concentrate on the automobile industry and the position of the European actors in this industry. It will address the following questions:

- Does sustainable development require a new paradigm for the industry or can it be considered a logical evolution of evolving practices and strategies?
- Are the relative competitive positions of different firms and regions of the world being redefined by the new requirements of the sustainable development framework?
- Are there different levels of ability to develop the synergies between the three dimensions and are these differences significant enough to generate sustainable competitive advantage as is proposed in the work “The Triple Bottom Line of the 21st Century Business” that is a founding stone of the new framework of sustainable development?
- Do these different levels of ability relate to qualities developed by the firms or to the economic, political and regulatory environments in which they operate?

In replying to these questions in relation to the automobile industry and in questioning directly how applicable these results are to other contexts, WP4 will enhance our understanding of how sustainable development can be encouraged and ‘engineered’.

The second perspective will centre more closely on the question of what organisations and procedures enhance the development of a strategy of a sustainable development at both micro and macro-economic levels. This question will be addressed both in operational terms and from a more political perspective. In operational terms, we will ask how firms seeking to progress in areas linked to sustainable development also continue to develop their other areas of activity and how these other activities are affected by the norms related to sustainable development. This issue will be addressed in relation to the cases concerning road safety, emissions regulation and corporate social responsibility. We will consider how true it is that policy makers have been more willing in recent times to adapt their procedures for developing norms by accepting more experimental and voluntary regulation on the part of firms and groups of firms. From a political perspective, this form of reasoning may lead to accusations of the ‘privatisation of norms’ in which all that is made obligatory is what firms or certain firms are able or willing to accept.

As researchers, we do not have to choose between the two points of view. Nonetheless, our research work will offer stakeholders the analytical and empirical elements needed to redefine the terms of the debate. Without oversimplifying reality, we will propose a configuration of trade-offs and synergies and analyse which are more and
which are less efficient in promoting sustainable development outcomes and which are more and which are less democratic in designing and implementing an operational framework.

REFERENCES


[한국어 요약(Korean Abstract)]
본 연구는 자동차산업에서 지속가능발전을 추구하는 가운데 고용, 경쟁, 정책, 비용, 수요 등 다양한 차원에서 나타날 수 있는 상각관계와 시너지에 초점을 맞추고 있다. 최근 주목 받고 있는 지속가능발전을 경제적 경쟁우위, 사회적 책임, 환경보호를 아우르는 개념으로 정의하였다. 지속가능발전의 세가지 차원을 통합해 시너지를 창출하는 노력은 기업과 공공정책 차원에서 중요성이 높아지고 있다. 이 때문에 지속가능발전에 대해 지난 수년간 논의와 적용의 과정을 거쳐서 새로운 프레임워크의 필요성이 높아지고 있다. 기존에 논의되어왔던 지속가능발전에 대한 원론적인 수준에서 더 나아가 실제 적용과 관련된 분석이 필요하게 된 것이다. 새로운 프레임워크는 지속가능발전이 업체, 정책, 연관산업 등과 긴밀히 연결되어 있으므로 이들의 연관성을 반영하고 기업이 전략을 수립하고 지속가능발전을 수행하게 되는 정책, 경제, 사회적 측면을 고려하였다. 새로운 연구 프레임워크를 구성하고 이에 따른 분석을 위해 본 연구는 총 4개의 연구 패키지(work package)를 구성했다. 제1 연구패키지에서는 자동차산업에서 지속가능발전의 새로운 정의를 도출하고 상각관계와 시너지에 관한 가설을 수립하였다. 제2 연구패키지에서는 지속가능발전의 상각관계와 시너지가 기업 내부에서 어떻게 나타나는지를 살펴보고, 제3 연구패키지에서는 자동차산업 발전에 영향을 미치는 거시경제, 사회, 정책, 정책적 환경에서의 지속가능발전의 상각관계와 시너지를 분석하였다. 제4 연구패키지에서는 제2 연구패키지와 제3 연구패키지를 통합해 기업과 공공정책 측면에서 이 새로운 프레임워크가 유합과 클로벌 자동차산업 환경에 적용될 수 있는지 분석하고 평가하였다.
Manufacturing companies are under increasingly diverse and mounting pressures due to more sophisticated markets, changing customer choice and global competition. The market for products is becoming increasingly international. In such a competitive scenario, companies have to search for new processes, new materials, new vendors, new shop floor designs, and new channels to deliver products and services at competitive price. Indian manufacturing companies have been thrust

Manufacturing Strategy: Evidences from Indian Automotive Industry

Abstract - Increasing competition is compelling firms continuously to search for new and better methods to reduce the costs and enhance quality. Indian manufacturing companies have quite often followed an opportunistic approach to growth as opposed to a capability driven approach, and paid very little strategic attention to their shop floors in the last few decades. In view of the emerging competitive scenario, it is envisaged that manufacturing strategy is needed for Indian companies. The paper presents findings of a study conducted in Indian automotive industry. In this research a structured questionnaire methodology is used to assess various manufacturing strategy issues through exploratory survey followed by three case studies. Final version of questionnaire is administered in 150 automotive manufacturing companies in all parts of India and 66 filled responses (with 44 % response rate) were analyzed. Competitive priorities and advanced manufacturing technologies (AMT) are identified and presented. It is observed that Indian companies are investing more in 'administrative AMT' to simplify the system; 'indirect AMT' is their second preferred choice to integrate the various systems, and finally to automate the manufacturing systems the companies are investing in 'direct AMT'. It seems Indian automotive manufacturing companies follow SIA (Simplify - Integrate - Automate) model. The survey findings are validated in three automotive companies through case study methodology.

Keywords - Manufacturing strategy, Automotive industry, Competitive priority, Advanced manufacturing technologies.

Dr. Govind Sharan Dangayach is Associate Professor in Mechanical Engineering Department at Malaviya National Institute of Technology Jaipur(India). He earned his Doctorate in Industrial Engineering at Indian Institute of Technology, Delhi. He is a guest editor of International Journal of Manufacturing Technology & Management (IJMTM) and International Journal of Business Performance Management (IJBPM). He is on Editorial Board of West Indian Journal of Engineering.
(e-mail: dangayach@gmail.com)

Manufacturing companies are under increasingly diverse and mounting pressures due to more sophisticated markets, changing customer choice and global competition. The market for products is becoming increasingly international. In such a competitive scenario companies have to search for new processes, new materials, new vendors, new shop floor designs, and new channels to deliver products and services at competitive price. Indian manufacturing companies have been thrust
from the protected environment of the “license-permit-quota” regime to an uncertain environment of liberalization, privatization, and globalization, which provide intense global competition. Increasing competition is compelling firms continuously to search for new and better methods to reduce the costs and enhance quality. It creates new opportunities, yet at the same time exposes manufacturers to more competition. With the globalization broadening customers are placing greater demands on manufacturers to increase quality while maintaining or lowering the costs.

Indian companies have quite often followed an opportunistic approach to growth as opposed to a capability driven approach, and paid very little strategic attention to their shop floors in the last few decades (Dangayach and Deshmukh 2006). This was reflected in poor quality of products, little awareness about competitiveness, little integration of various functions such as marketing, sales, production, etc. In view of the emerging competitive scenario, it is envisaged that manufacturing strategy is needed for Indian companies.

Skinner (1969) gave the concept of manufacturing strategy. According to him “manufacturing strategy” refers to exploiting certain properties of the manufacturing function as a competitive weapon. The manufacturing strategy is a plan that describes the way to produce and distribute the product. It is defined by APICS dictionary as “A collective pattern of decisions that acts upon the formulation and deployment of manufacturing resources. To be most effective, the manufacturing strategy should act in support of the overall strategic directions of the business and provide for competitive advantages” (Cox and Blackstone 1998).

The paper consists of 9 sections. Next section describes Indian manufacturing industry and automotive sector. Section 3 presents scale development and research propositions. Research methodology used in the study is presented in section 4. Section 5 explains research methodology used in the study. Observations, analysis and discussions were dealt in section 5. Three case studies are developed and presented in section 6. Concluding remarks are presented in section 7 followed by implications and scope for future research.

### Indian Manufacturing Industry

Manufacturing industry is made up of many different sectors, each of which is influenced by the overall-manufacturing climate. From the Indian perspective, the major manufacturing sectors are automotive, electronics, machinery, and process industries. Table 1 gives the comparative statistics of all four sectors (Statistical outline of India 1999-2000).

#### TABLE 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Auto</th>
<th>Elec</th>
<th>Mach</th>
<th>Proc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (billion US $)</td>
<td>55</td>
<td>65</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>Percentage of National Export</td>
<td>16.5</td>
<td>18.3</td>
<td>1.6</td>
<td>17.0</td>
</tr>
<tr>
<td>Percentage Market share of primary product</td>
<td>33.6</td>
<td>18.8</td>
<td>28.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Capacity utilization (%)</td>
<td>80.0</td>
<td>69.6</td>
<td>64.2</td>
<td>91.7</td>
</tr>
<tr>
<td>Average manufacturing lead time (days)</td>
<td>19.2</td>
<td>13.3</td>
<td>74.7</td>
<td>30.0</td>
</tr>
<tr>
<td>Foreign Direct Investment</td>
<td>54</td>
<td>60</td>
<td>N/A</td>
<td>3.5</td>
</tr>
</tbody>
</table>

*Auto - Automotive, Elec - Electronics, Mach - Machinery, Proc - Process*

### The Indian Automotive Sector

The global automotive industry is an important component of industrial and economic progress and its development has characterized global competitiveness of leading industrialized economies. This industry is fairly developed one, and involves huge investments in research and development, and technology. It is also seen as an indicator of the economic progress of the country. An understanding of the automotive industry in some of the developed countries enables one to study the emerging trends in the developing countries.

Since introduction of economic reforms in 1991, Indian companies are facing a very different competitive scenario compared to the past. The abolition of license regime meant end of protection and control measures. Manufacturing in India is at a critical juncture. Generally in Indian perspective manufacturing is a support activity for marketing and finance, and therefore have got little top management attention. Most of companies are still very far from world-class practices. Meanwhile interna-
tional competitors are continuously working on improving manufacturing, bringing in new products and making manufacturing more proactive and responsive (Chandra and Sastry 1998). Indian industry is facing competition both from imports and multinational companies in the domestic markets. The new competition is in terms of reduced cost; improved quality, products with higher performance, a wider range of products and better service, all delivered simultaneously. The automotive industry is no exception to this. Here the term “automotive industry” is used to include two wheeler, four wheeler (passenger cars) and auto component manufacturers. Table 1 shows various phases undergone in Indian auto industry.

In addition, Indian automotive industry has witnessed entry of global players such as Ford, General Motors, Suzuki, Honda, Mercedes, Daewoo, Santro etc. in four wheeler segment, whereas Piaggio, Suzuki, Honda, Yamaha, Kawasaki etc. in two wheeler segment. The Indian market for two wheelers is the second largest in the world after China. Scooters represented 45% of these unit sales, motorbikes 37%, and mopeds 18%. The two wheeler industry today has a significant role in the Indian economy. With an annual turnover of 155 billion US $ and a compounded average growth rate of 10% in recent years, it is one of the few industrial sectors in the growth phase today (Kumar 1998).

In this study, following research questions relating to Indian automotive manufacturing companies were explored through survey and case studies:

- What are competitive priorities of Indian automotive manufacturing companies?
- Which advanced manufacturing technologies (AMT) are important for this sector?
- What are the trends in adopting of advanced manufacturing technologies?
- How AMT are implemented?

**Scale Development and Research Propositions**

Skinner (1969) gave the concept of manufacturing strategy. According to him “manufacturing strategy” refers to exploiting certain properties of the manufacturing function as a competitive weapon. After Skinner’s (1969) landmark article, manufacturing strategy has received lot of attention from various researchers. Various researchers (Skinner 1969; Hill 1989; Gerwin 1993) elaborated on customer expectations on attributes such as cost, quality, delivery, and flexibility, which are popularly termed as competitive priorities or manufacturing performance objectives. Competitive priorities have been established as a major building block in manufacturing strategy research (Hayes and wheelwright 1984; Gerwin 1993; Upton 1994).

Hill (1989) introduced the concept of order winners and order qualifiers and differentiated between them. Order winners are those things, which directly and significantly contribute to winning business. Customers regard them as the key reasons for purchasing the product or service. Order

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase</th>
<th>Characteristics Two Wheelers</th>
<th>Characteristics Passenger Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1980</td>
<td>Phase of limited supply</td>
<td>- Long waiting list</td>
<td>- Limited buying capacity of consumers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Huge pent up demand</td>
<td>- Limited number of companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Limited companies</td>
<td></td>
</tr>
<tr>
<td>1981-1990</td>
<td>Phase of take off</td>
<td>Entry of new global players such as Suzuki, Kawasaki, Honda, Piaggio etc</td>
<td>Entry of new global players such as Hyundai, Daewoo, Toyota, Ford, Mercedes Benz etc.</td>
</tr>
<tr>
<td>1991 onwards</td>
<td>Phase of consolidation</td>
<td>- Rapid acceptance in urban &amp; rural markets</td>
<td>- Increase in buying capacity of consumer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Average growth rate 20% p.a.</td>
<td>- Easy finance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- More variety</td>
</tr>
</tbody>
</table>
qualifiers are those criteria that a company must meet for a customer even to consider it as a competitor. In addition, Hill (1989) suggested structural and infrastructural issues as two pillars of manufacturing strategy. Structural issues sets the process and technology for operations whereas infrastructure provide it long term competitive edge by continuously improving upon human resource policies, quality management systems, organization culture, and information technology.

Advanced manufacturing technologies (AMT) are action plans in which a company invests to improve upon its structure and infrastructure. AMT are often regarded as “ready-to-wear” sets of structural and infrastructural issues. A company selects the AMT in order to build the manufacturing capabilities required by the market (Kim and Arnold 1996). Advanced manufacturing technologies are used for operationalising the manufacturing strategy.

Many researchers conducted surveys in developed and developing countries to assess manufacturing strategy issues. In Indian context reported studies (Chandra and Sastry 1998; Nagabhushana and Shah 1999; Korgaonker 2000; Dangayach and Deshmukh 2001; Dangayach and Deshmukh 2006) were general. There is still lack of in-depth sector specific study especially for automotive sector in developing country like India. This research aimed to fill this gap. Key manufacturing strategy issues are given below.

**Competitive Priorities**

Manufacturing capabilities represent a holistic set of tasks, which should be performed by the manufacturing function in order to support the business strategy; and the degree of relative emphasis given to each of them represents manufacturing’s competitive priorities. Various researchers (Hayes and Wheelwright 1984; Hill 1989; Gerwin 1993; Kim and Arnold 1996) described four distinct competitive priorities—cost, quality, flexibility, and delivery.

*Proposition 1: Quality, delivery, flexibility, and cost form the basic dimensions of manufacturing priorities for Indian automotive companies.*

**Competitive Progression Theory**

According to this theory, competitive capabilities (quality (Q), delivery (D), flexibility (F), and cost (C)) accumulate in a sequential progression forward-from quality to delivery to flexibility to cost-over an innovation cycle (Roth 1996). Competitive progression theory posits that quality is a prerequisite for the long-term capability development. The pursuit of quality affords effective and efficient approaches to process variance reduction and organizational learning (continuous improvement). Changing one capability will automatically impact the others e.g. if a company is working toward six sigma product quality, a portion of this effort transfer into better delivery, since there is less rework, better process predictability, and more residual organizational energy to devote to delivery. Therefore, 
\[(\Delta D = x (a_2, \Delta Q)),\]
where, \(a_i = \text{capability specific process properties}, i = 1 \text{ to } 4 \text{ for } Q, D, F, \text{ and } C \text{ respectively. For consistent, on-time deliveries, more extensive process predictability is required. Quality and delivery pave the way for flexibility. Therefore, } (\Delta F = y (a_3, \Delta Q, \Delta D)). \]
Similarly, sustainable cost leadership occurs only when product innovations and processes add to the company’s competitive arsenal by reducing total costs over a product-family life cycle, and therefore 
\[(\Delta C = z (a_4, \Delta Q, \Delta D, \Delta F)).\]
The above discussion leads to formulation of Proposition 2.

*Proposition 2: Indian automotive manufacturing companies follow the competitive progression theory.*

**Advanced Manufacturing Technologies**

To accomplish its strategic goals and objectives, a company needs to select and implement a range of advanced manufacturing technologies, which may be technological, organizational or people based. Advanced manufacturing technologies are action plan in which, a company invests to improve its structure and infrastructure. A company selects the advanced manufacturing technologies in order to build the manufacturing capabilities required by the market (Kim and Arnold 1996).

Based on the literature (Clark 1996; Udo and Ehie 1996), and discussions with practitioners a set of 16-items is identi-
fied to measure investment in advanced manufacturing technologies, relevant for Indian companies to address issues in manufacturing strategy (Appendix A). These advanced manufacturing technologies (AMT) were classified into direct AMT (DAMT), indirect AMT (IAMT), and administrative AMT (AAMT). It must be mentioned that this set is by no means an exhaustive set of activities. However, it captures the essence of advanced manufacturing technologies as practiced by Indian automotive companies.

Hardware base technologies termed as direct AMT. Software based technologies used for product design and scheduling are termed as indirect AMT, however administrative AMT are used for integration and simplification of business processes.

- Direct AMT: Technology used on the factory floor to cut, join, reshape, transport, store or modify materials e.g. CNC, DNC, robotics, FMS, AS/RS, AMHS, AGV, RP etc.
- Indirect AMT: Technology used to design products and schedule production e.g. CAD, MRP, SPC, BC, MRP II etc.
- Administrative AMT: Technology used to give administrative support to the factory and integrate its operations with the rest of the organization e.g. ERP, ABC, OA etc.

Based on the above discussion, the following proposition is formulated

**Proposition 3:** Indian automotive companies are investing more in administrative AMT (AAMT) as compared to direct AMT (DAMT) and indirect AMT (IAMT).

**AMT Implementation Steps**

Based on literature (Badiru 1990; Schroder and Sohal 1999; Efstahiades, Tassou, and Antoniou 2002) eight steps are identified for effective AMT implementation. These eight steps are ‘planning’, ‘concept development’, ‘requirement analysis’, ‘cost/benefit analysis’, ‘technology assessment’, ‘development and implementation’, ‘training’, ‘post-implementation evaluation’. Companies with varying importance use these steps. This discussion leads to formulation of proposition 4.

**Proposition 4:** Indian automotive companies are using AMT implementation steps by giving varying importance.

Above four propositions are framed based on gaps identified in the literature. These are related to various issues in manufacturing strategy. The aim is to test these propositions through a survey of Indian automotive manufacturing companies. The research design can be summarized in Table 3.

**TABLE 3**

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposition 1</td>
<td>Identification of competitive priorities</td>
</tr>
<tr>
<td>Proposition 2</td>
<td>Companies follow competitive progression</td>
</tr>
<tr>
<td>Proposition 3</td>
<td>Advanced Manufacturing Technologies</td>
</tr>
<tr>
<td>Proposition 4</td>
<td>Relative importance to AMT implementation steps</td>
</tr>
</tbody>
</table>

**Research Methodology**

The purpose of this study is to gain in-depth understanding of manufacturing strategy (MS) practices in Indian automotive companies through survey and case studies. The objective of survey is to examine the status of manufacturing strategy in Indian automotive manufacturing companies. A database of 150 automotive sector companies has been extracted from all over the country from the CII (Confederation of Indian Industry) Industrial directory. Selection criterion was based on two parameters i.e. number of employees ($\geq 100$) and annual sales ($\geq 0.25$ million US $). landscape. Case studies are longitudinal in nature and one attribute is to be discussed with more than one manager for collection of data, therefore non-response bias is reduced to minimum. Various researchers used case study for their research (Maruchek, Pannesi, and Anderson 1990; Shrivastava 1995; Cheng and Musaphir 1996; Menda and
Three automotive manufacturing companies were selected for case study. These include one company that is a leading four wheeler manufacturer (labeled as company A), and other two companies are two-wheeler manufacturer (labeled as Company B & C). The indicative research questions involved in the case study are:

- Manufacturing mission/vision
- Methodology used for formulation and implementation of manufacturing strategy
- How is MS formulated?
- How is MS related to marketing strategy?
- Who is responsible for the formulation of the strategy?
- How is MS related to corporate strategy?
- Competitive priorities of the companies
- Order winners/order qualifiers
- Critical success factors

**Development of Questionnaire**

Based on the literature and study of Indian automotive industry a questionnaire was designed. The questionnaire has been developed on a five point Likert scale. The questionnaire contained two sections ‘A’ and ‘B’. Section ‘A’ contained questions, pertaining to company profile and section ‘B’ contained questions related to competitive priorities, Advanced Manufacturing Technologies, order winners etc. The questionnaire also contained a few yes/no types of items and a few open-ended items to elicit the response.

**Content Validity**

Flynn et al. (1990) and Malhotra and Grover (1998) identified norms for survey research. These norms were followed in the present research. The unit of analysis in this study is a company. A company is the highest level where manufacturing strategy is integrated with marketing strategy. In our survey majority of respondents were of Vice President/Divisional Manager/Works Manager/Production Manager level and thus appropriate for research questions. Both multi-item and single item questions were included as suggested by Malhotra and Grover (1998). To reduce sampling error, a random sample of 150 companies was drawn and response rate was higher than 20% as suggested by Malhotra and Grover (1998).

To assess the content validity a “dry run” was made and few questionnaires were pilot-tested with leading practitioners, consultants and academicians. Based on their feedback, the present form has been evolved and final version of the questionnaire was sent.

**Reliability Analysis**

Inter-item analysis is used to check the scales for internal consistency or reliability. Cronbach’s coefficient alpha is calculated for each scale, as recommended for empirical research in operation management (Flynn, Sakakibara, Schroeder, Bates, and Flynn 1990; Malhotra and Grover 1998). SPSS for windows package (version 10) is used for calculation of Cronbach’s Alpha. Cronbach’s alpha values are calculated for 66 responses received. Values for few items appeared less than 0.5 and thus these scales were excluded from analysis. Cronbach’s alpha values more than 0.5 are considered adequate for the exploratory work (Nunally 1978).

**TABLE 4**

Statistics of the Respondent Companies

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 100</td>
<td>09 (12)</td>
</tr>
<tr>
<td>2. 101-500</td>
<td>10 (15)</td>
</tr>
<tr>
<td>3. 501-1000</td>
<td>16 (24)</td>
</tr>
<tr>
<td>4. 1001-3000</td>
<td>25 (38)</td>
</tr>
<tr>
<td>5. 3001-5000</td>
<td>07 (11)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Sales (million US $)</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 0.25-1.25</td>
<td>07 (11)</td>
</tr>
<tr>
<td>2. 1.25-2.5</td>
<td>10 (15)</td>
</tr>
<tr>
<td>3. 2.5-12.5</td>
<td>15 (23)</td>
</tr>
<tr>
<td>4. 12.5-25</td>
<td>12 (18)</td>
</tr>
<tr>
<td>5. &gt; 25</td>
<td>22 (33)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exports (% of total sales)</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nil</td>
<td>24 (37)</td>
</tr>
<tr>
<td>2. 10 %</td>
<td>30 (45)</td>
</tr>
<tr>
<td>3. 10-20 %</td>
<td>05 (7)</td>
</tr>
<tr>
<td>4. 20-30 %</td>
<td>04 (6)</td>
</tr>
<tr>
<td>5. &gt; 30 %</td>
<td>03 (5)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

Figures in **bold** refer to modal responses
**Questionnaire Administration**

Final version of the questionnaire was sent to CEO of 150 Indian automotive manufacturing companies. After the reminders, phone calls, e-mail and re-reminders, 66 filled responses have been received, which gives 44% response rate. Table 4 gives the statistics of the respondent companies. Average profile of the respondents is given in Table 5.

**Competitive Priorities**

Table 6 shows the mean and standard deviation of competitive priorities i.e. quality, delivery, flexibility, and cost. For each priority, respondents were asked to indicate the degree of importance on a five point Likert scale (1- least important, 5 - most important). Table 6 depicts that top most competitive priority is quality. Flexibility and cost are the least preferred competitive priority for Indian automotive manufacturing companies. The above results support the Proposition 1. Table 7 shows the correlation between 4-items of competitive priorities. All competitive priorities are significantly correlated (p < 0.05) with other priorities. The correlations imply that the manufacturing companies in the survey are strongly emphasizing on these competitive priorities. The Cronbach’s alpha for the scale is 0.7898, which indicates a high level of internal consistency among items (Nunally 1978).

**Competitive Progression Theory**

It is observed from Table 6 that Indian automotive manufacturing companies (n=66) are giving importance to quality, delivery, flexibility, and cost in descending order. This supports the competitive progression theory (Figure 1) proposed by Roth (1996). Presently, Indian manufacturing companies are trying to achieve superior quality, then delivery, flexibility, and cost respectively. Roth (1996) empirically tested this theory in US, Japanese, and European samples and observed strong support to the competitive progression theory. Indian companies are too following a similar path i.e. quality to delivery to flexibility to cost. Therefore it can be said that Indian companies although started late, but moving in similar direction as that of their counterparts in developed economy. This supports Proposition 2.

**Advanced Manufacturing Technologies (AMT)**

Based on the literature, 16 AMT were identified for the Indian companies to address issues in manufacturing strategy. These include Direct AMT (DAMT- 8 items), Indirect AMT (IAMT-5 items), and Administrative AMT (AAMT-3 items). A detailed list and explanation of each AMT is given in (Appendix A). Respondents were asked to indicate degree of investment in above AMT in their companies on a five point Likert scale (where 1- No investment and 5 - 100% investment). Table 8 shows the mean and standard deviation for these 16 AMT. Overall mean score is represented for all three AMT i.e. DAMT (overall mean=2.50), IAMT (overall mean=3.09), and AAMT (overall mean=3.16). It is observed that Indian automotive companies are investing more in administrative AMT and the least preferred is direct AMT. It seems that automotive sector companies have started restructuring themselves to keep pace with the global competition. The above results support proposition 3.
Direct AMT (DAMT). Figure 2 represents normalized results for the mean score of eight direct AMT as responded by Indian automotive companies. A normalized score is calculated by finding the difference between a score of each activity and the average of all activities. For example the mean score of CNC is 3.24 and average of 1-5 Likert scale is 3, thus normalized score for CNC is (3.24-3)/2 i.e. 0.12. This procedure eliminates the inter-company bias i.e. some respondents tend to assign higher values to all activities than other respondents (Kim and Arnold 1996). If the normalized score is positive, it is inferred that the company has preferred more investment in that activity as compared to other negative scored activities. Figure 2 shows that normalized score for computer numerical control (CNC) is positive others are negative. It reflects that the most preferred DAMT is computer numerical control (CNC, mean=3.24), whereas the least preferred DAMT is automated guided vehicle (AGV, mean=2.07).

Table 9 shows the correlation between 8-items of direct AMT. All DAMT are significantly correlated (p ≤ 0.05) with each other except AGV and CNC. The correlations imply that the manufacturing companies are emphasizing on these activities. The Cronbach’s alpha for the 8-item scale is 0.8946, which indicates a high level of internal consistency among the items.

![FIGURE 1 Competitive Progression Model](image1)

![FIGURE 2 Investment in Direct AMT](image2)

![FIGURE 3 Investment in Indirect AMT](image3)

![FIGURE 4 Investment in Administrative AMT](image4)

### TABLE 8

<table>
<thead>
<tr>
<th>Advanced Manufacturing Technologies</th>
<th>Mean (N = 66)</th>
<th>Standard deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC</td>
<td>3.24</td>
<td>1.52</td>
<td>5</td>
</tr>
<tr>
<td>DNC</td>
<td>2.73</td>
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<td>10</td>
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<tr>
<td>RO</td>
<td>2.24</td>
<td>1.54</td>
<td>13</td>
</tr>
<tr>
<td>FMS</td>
<td>2.78</td>
<td>1.43</td>
<td>9</td>
</tr>
<tr>
<td>AMHS</td>
<td>2.53</td>
<td>1.42</td>
<td>11</td>
</tr>
<tr>
<td>AGV</td>
<td>2.07</td>
<td>1.31</td>
<td>16</td>
</tr>
<tr>
<td>ASRS</td>
<td>2.23</td>
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<td>14</td>
</tr>
<tr>
<td>RP</td>
<td>2.18</td>
<td>1.34</td>
<td>15</td>
</tr>
<tr>
<td><strong>Overall statistics</strong></td>
<td><strong>2.50</strong></td>
<td><strong>1.44</strong></td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>3.25</td>
<td>1.30</td>
<td>4</td>
</tr>
<tr>
<td>MRP</td>
<td>3.42</td>
<td>1.27</td>
<td>2</td>
</tr>
<tr>
<td>SPC</td>
<td>3.02</td>
<td>1.18</td>
<td>7</td>
</tr>
<tr>
<td>BC</td>
<td>2.36</td>
<td>1.45</td>
<td>12</td>
</tr>
<tr>
<td>MRPII</td>
<td>3.40</td>
<td>1.28</td>
<td>3</td>
</tr>
<tr>
<td><strong>Overall statistics</strong></td>
<td><strong>3.09</strong></td>
<td><strong>1.29</strong></td>
<td></td>
</tr>
<tr>
<td>ERP</td>
<td>2.98</td>
<td>1.51</td>
<td>8</td>
</tr>
<tr>
<td>ABC</td>
<td>3.05</td>
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<td>6</td>
</tr>
<tr>
<td>OA</td>
<td>3.45(^{a})</td>
<td>1.25(^{a})</td>
<td>1</td>
</tr>
<tr>
<td><strong>Overall statistics</strong></td>
<td><strong>3.16</strong></td>
<td><strong>1.36</strong></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) Italic - Highest score
To eliminate inter-company bias, a normalized score is calculated by finding the differences between a score of each activity and the average of all activities.

*Indirect AMT (IAMT).* Figure 3 shows the normalized results for the mean score of each 5 indirect AMT. It is observed that Material requirement planning (MRP) is the top preferred indirect AMT (mean = 3.42). MRP is the first step in the integration of various engineering departments. Therefore, it seems that Indian companies have realized the importance of this and have started integrating their functions. MRP is also important in the present era of supply chain management. Table 10 shows the correlation between 5-items of IAMT. All IAMT are significantly correlated (p ≤ 0.05) with other except bar coding (BC). Bar coding have insignificant correlation with SPC, MRP and MRPII. The Cronbach’s alpha for the 5-item scale is 0.7433, which indicates a high level of internal consistency among items.

*Administrative AMT (AAMT).* Mean score for 3-items of AAMT is given in Table 8. It is observed that companies are investing highly in office automation (OA) activities (mean = 3.45). This activity got highest mean score among all 16 items of AMT i.e. direct AMT, indirect AMT, and administrative AMT. Figure 4 shows the normalized results for the mean score of 3 administrative AMT. Table 11 shows the correlation between 3-items of AAMT. Only activity based costing (ABC) is significantly correlated (p ≤ 0.05) with enterprise resource planning (ERP). The Cronbach’s alpha for the 3-item scale is 0.5247, which is more than 0.5 as suggested by Nunally (1978).

*AMT implementation steps.* Respondents were asked to give importance to these eight implementation steps on five point Likert scale (Interval scale 1-5: 1 - least important and 5 - most important). Table 12 gives mean and standard deviation values. It is observed from Table 12, that ‘development and implementation’ step is most important and ‘requirement analysis’ is the least important AMT implementation step for
Indian automotive manufacturing company. This supports proposition 4.

Correlation between eight AMT implementation steps is given in Table 13. It is observed that all AMT implementation steps are positively correlated and significant at the 0.01 levels. Correlation between ‘planning’ and ‘concept development’ is the highest (0.84), however correlation between ‘planning’ and ‘training’ is the lowest (0.418). It seems true because concept development is not possible without proper planning.

**TABLE 12**
AMT Implementation Steps

<table>
<thead>
<tr>
<th>AMT implementation steps</th>
<th>Mean (N = 66)</th>
<th>Standard deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS 1</td>
<td>3.92</td>
<td>1.22</td>
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<tr>
<td>AIS 2</td>
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<td>AIS 3</td>
<td>3.58</td>
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<td>AIS 4</td>
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<td>AIS 5</td>
<td>3.84</td>
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<td>AIS 6</td>
<td>4.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td>AIS 7</td>
<td>3.80</td>
<td>1.09</td>
<td>5</td>
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<tr>
<td>AIS 8</td>
<td>3.80</td>
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<td>6</td>
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<tr>
<td>Overall statistics</td>
<td>3.80</td>
<td>1.20</td>
<td></td>
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</tbody>
</table>

<sup>a</sup> Italics - Highest score

**TABLE 13**
Correlation among AMT Implementation Steps

<table>
<thead>
<tr>
<th>AIS 1&lt;sup&gt;**&lt;/sup&gt;</th>
<th>1.000</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>AIS 2&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.840**</td>
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<td></td>
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<tr>
<td>AIS 3&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.645**</td>
<td>0.701**</td>
<td>1.000</td>
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<tr>
<td>AIS 4&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.583**</td>
<td>0.578**</td>
<td>0.677**</td>
<td>1.000</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>AIS 5&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.552**</td>
<td>0.585**</td>
<td>0.612**</td>
<td>0.737**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIS 6&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.576**</td>
<td>0.611**</td>
<td>0.584**</td>
<td>0.652**</td>
<td>0.783**</td>
<td>1.000</td>
<td></td>
<td></td>
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<tr>
<td>AIS 7&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.418**</td>
<td>0.458**</td>
<td>0.442**</td>
<td>0.442**</td>
<td>0.621**</td>
<td>0.692**</td>
<td>1.000</td>
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<tr>
<td>AIS 8&lt;sup&gt;**&lt;/sup&gt;</td>
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<td>0.616**</td>
<td>0.504**</td>
<td>0.565**</td>
<td>0.682**</td>
<td>0.683**</td>
<td>0.728**</td>
<td>1.000</td>
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</tbody>
</table>

**<sup>**</sup> Correlation is significant at the 0.01 Level (2 - Tailed)
AIS 1 - Planning
AIS 2 - Concept development
AIS 3 - Requirement analysis
AIS 4 - Cost/benefit analysis
AIS 5 - Technology assessment
AIS 6 - Development & implementation
AIS 7 - Training
AIS 8 - Post-implementation evaluation

**Company ‘A’**

**The Setting.** Company ‘A’ is a leading manufacturer of all types of four wheeler vehicles. It produces a wide range of diesel commercial vehicles (heavy, medium and light commercial vehicles) and passenger cars. It manufactures 24 models of these vehicles. The company is the largest motor vehicle manufacturer in India and sixth largest commercial vehicle manufacturer in the world. It was established in 1945 and belongs to a giant industrial group of India, which produces diverse range of product in the plants all over the country. The company operates in multi-plant environment with 3 plants in various parts
of the country. It enjoys 60% market share in domestic market for light commercial vehicles and 72% in medium and heavy commercial vehicles. Annual turnover of the company is 500 billion US$. The company exports are about 30% of total sales. It exports its products to the countries such as Paraguay, Hungary, Argentina, and Chile.

Vision. To develop the company with excellent capabilities in design, engineering, manufacturing and marketing.

Mission. To be a leader in all types of vehicle manufacturer

Marketing strategy. The company sets high target for future. The company focuses at a time one-market segment, develop capability and then move into the next segment, taking advantage of previous one. It is reflected with following facts:

- From 1956~1985: devoted to development of heavy commercial vehicles (trucks and buses).
- 1986~1993: development of light commercial vehicles (diesel Jeep type four wheelers)
- 1994 onwards: development of diesel passenger car (1000 cc four door car)

Corporate strategy:

- Develop indigenous competence with acquisition of technology from abroad
- Upgrade the manufacturing technology
- Producing a variety of products which can cater to all major segments
- Development of a large dealer network
- Systematic human resource development
- Continue investment in research and development

Manufacturing strategy development methodology. The company has an informal method of formulation of manufacturing strategy (MS) in line with marketing strategy. Figure 5 shows the process of manufacturing strategy formulation method of the company ‘A’. Vital elements of its MS are

- High investment in advanced manufacturing technology such as CAD, CAM, Shop floor automation, and concurrent engineering.
- Emphasis on continuous improvement of manufacturing system
- High innovation rate, (the company has its own engineering research center with 1100 employees. It’s R & D expenditure is about 50 million US$.

Human resource policy:

- The company had established a full fledge training center in eastern part of the country in 1966.
- Linked career progress with skill development
- Recognition of employees for excellent work

Competitive priorities.
Rank wise competitive priorities of the company ‘A’ are:

- Quality
- Delivery speed
- Low cost
- Flexibility

Order qualifiers.

- Technology leadership
- On time delivery
- Product quality

Order winners.

- User friendliness
- Cost effectiveness
- After sales management

Critical success factors.

- Excellent dealer network all over the country
- Clarity of vision
- Brand image
- High quality of products
- Good after sales service
- Investment in core technology
- High innovation rate
Continuous improvement of manufacturing
Strong customer focus

**Company ‘B’**

*The Setting.* Company ‘B’ is one of the oldest two-wheeler automobile manufacturing company (established in 1945). It belongs to a big industrial group and operates in a multi-plant environment (two plants). Other companies of this group produce electrical appliances, sugar etc. Both plants of the company ‘B’ are located in central part of India. The company produces two wheeler (9 models) and three wheeler (3 models) vehicles. Two wheelers include Scooters (5 models), two stroke and four stroke Motorbikes (3 models), and Mopeds (1 model). In 1960 the company came into technical collaboration (for scooter manufacturing) with a leading Italian two wheeler manufacturing company. In 1984 it entered in motorbike and moped production segment after technical collaboration with Japanese two wheeler giant. In 1985 it established second plant after relaxation in industrial policy. With 11000 employees, it enjoys 40 % market share in two wheeler segments. Presently the company ‘B’ is the 3rd largest manufacturer of two and three wheeler vehicles in the world and has 15% exports of total sales

**Previous approach.** During 1950-1980, an era of limited supply, government’s industrial policy was restrictive and regulative, therefore company’s production was very less than demand. During this period waiting list for scooters was 10 years. Being the oldest company in two wheeler sector, the company enjoyed monopoly status in earlier years. Initially the company did not have a marketing department since demand outstripped capacity and it enjoyed a protected seller’s market. Therefore it had no specific strategy till 1980s. After relaxation in industrial policy many new companies have entered in this sector with Japanese collaboration. In 1980s company grown explosively and its production volume increases from 172 to 800 thousand units a year.

Due to increased competition the company created a marketing department (in 1993), which focused on increasing annual sales to 1 million units. The company decided to modernize plants and increase production efficiency. It invested in advanced manufacturing technologies (AMTs) such as CAD, CAM, CNC machines etc. and framed a marketing strategy

*Vision.* To become market leader in two wheeler segments.

*Mission.* To provide low cost, fuel efficient two wheelers to customers.
Elements of marketing strategy:
- Increase dealer network all over the country including rural area.
- Dealers are not to be permitted to have other two wheeler brands.
- Periodically introducing new product (company increased its models from 5 in 1985 to 12 in 1992)
- 50% components to be produced through vendors.
- To improve product distribution and service network by deploying 50 service engineers at dealership to upgrade the technical capability of dealer service personnel.
- To provide service and advertising support to the dealers, by giving training to their staff in company’s plants.
- To sell the product at competitive price i.e. lowers than competitors.
- Increase investment in advertising and describe additional features.
- To address competitor claims head on.
- To start its own financing company to finance the vehicles.

Manufacturing strategy development methodology:
After setting up of marketing department, CEO of the company discussed with key marketing managers and framed a manufacturing strategy. Figure 6 shows the manufacturing strategy development procedure of the company A. Essential features of its manufacturing strategy are:
- Speed up the new product development by using AMT’s like CAD, CAM.
- Mission of manufacturing is continuous improvement with zero defects.
- Quality circles to be established to get suggestions for improvement at shop floor.
- Matching competitor product features by constantly improving existing product.

After implementation of manufacturing and marketing strategy company improved its lost market share. It increased its dealer network. The company had computerized distribution system with 30% of dealers connected through network and orders were directly fed into company’s production schedule.

Competitive priorities.
Rank wise competitive priorities of the company are:
- Low cost
- Quality
- Delivery speed
- Flexibility

Order qualifiers.
- Low cost
- Product durability
- Resale value

Order winners.
- Brand image
- New product development
- User friendliness
- Cost effectiveness
- After sales management

Critical success factors.
- Product durability
- Large and loyal dealer network
- Brand image
- Advertising
- Economic price
- Use of AMT
- Better HR policy

FIGURE 7
Manufacturing Strategy Formulation at Company ‘C’
Company ‘C’

The setting. The Indian market for two wheelers is the second largest in the world after China. Scooters represented 45% of these unit sales, motorbikes 37%, and mopeds 18%. Indian two wheeler industry has witnessed a proliferation of entrants into this sector following the liberalization of the economy. The major two wheeler manufacturers of the world such as Kawasaki, Honda, Piaggio, Yamaha etc. have entered into the Indian two wheeler market. The two wheeler industry today has a significant role in the Indian economy. With an annual turnover of 155 billion US $ and a compounded average growth rate of 10% in recent years, it is one of the few industrial sectors in the growth phase today. The consumer who wants to be mobile today considers personal transportation as one of his/her basic needs. In India two wheeler is used for a variety of purposes, particularly in urban areas like commuting to work, visiting people, carrying loads, for outdoor jobs etc. as opposed to the leisure/fun use common in developed countries. In rural areas, where the rough road conditions requires a sturdy vehicle, it enables people to travel more frequently to nearby towns for their daily needs. Younger, single male consumers, between 21 and 30 years of age, looks for power and style, prefer a motorbike for his personal transport. A series of favorable climatic conditions for agricultural commodities have increased the purchasing power of rural customers. Today the rural market of over six lakh Indian villages contributes about 35% of two wheeler sales.

The company ‘C’ operates in a multi-plant and multi-divisional environment in northern India. It has collaboration with a leading Japanese motorbike company with 26% equity share and produces four models of 4-stroke motorbike (coded as MB1, MB2, MB3 and MB4). The company was established in 1983 and its production rate is 1000 motorbikes/day. Present turnover of the company is 18 billion US $ and market share (Indian) is about 45% in 100 CC motorbike segment. The company has about 3000 employees.

Previous approach. Before liberalization (1991) in India, company ‘C’ was following industry practice due to license regime in India. Much of the time was spent in moving papers from one department to other. The total production of vehicles was 42000 per year, whereas booking of vehicles was nearly 5,00,000. The decision making process was centralized due to rigid vertical integration.

Present approach. After liberalization, due to intense competition, spurred by entry of multinationals, CEO of the company in consultation with group and division heads set a vision and mission for the company.

Vision. To be the leader in motorbike sector by following world class practices.

Mission. Continue efforts for the development of motorbike industry through new product development, technological innovation, investment in equipments, facilities and efficient management.

Develop core competencies and human resource to become market leader in economic and dependable transport system.

The firm has developed a testing facility spending 1% of total sales on research and development in which 90% of the testing is done locally. Most of the machines are computer numerical control (CNC) type.

Manufacturing strategy development methodology. Figure 7 shows the formal procedure of manufacturing strategy development at Company ‘C’. Broad corporate strategic objectives are formulated at corporate level, which provides a set of expectations for lower level strategy formulation such as marketing and manufacturing strategies. Plant level manufacturing strategy is being formulated by manufacturing personnel of various plants, which sets the norms for division level manufacturing strategy. Assessment of manufacturing objectives is made through a monthly meeting of division heads.
After liberalization in India (1991) i.e. after 8 years of establishment, company ‘C’ has started thinking rationally towards alignment of manufacturing and marketing strategy. It is clear with the statement that inspite of having good demand (5,00,000 units) firm could produce only 42,000 vehicles in a year. After having clear cut vision and mission and top management commitment company developed a manufacturing strategy which states develop enough technological capabilities to take maximum leverage from the resources committed to the technology of the firm’s products and processes. To support this strategy and to meet the market demand, decision was made to start one more unit within 50-km area of existing plant.

**Order qualifiers.**
- Competitive price
- On time delivery
- Product quality
- Useful life.

**Order winners.**
- Excellent mileage
- New product development
- User friendliness
- After sales management

**Concluding Remarks**

In this research effort, a survey of Indian automotive manufacturing companies is conducted to study several manufacturing strategy issues followed by development of cases. Responses were analyzed for various structural and infrastructural issues of manufacturing strategy such as competitive priorities (quality, flexibility, cost, and delivery) Advanced Manufacturing Technologies (direct AMT, indirect AMT, and administrative AMT) based on 66 responses. It is observed that the Indian manufacturing companies are emphasizing more on quality and the least on cost. It seems that Indian companies follow a progressive path to achieve competitive advantage i.e. quality to delivery to flexibility to cost. Indian companies are investing in Advanced Manufacturing Technologies i.e. direct AMT, indirect AMT, and administrative AMT in ascending order. The top five AMT in Indian automotive manufacturing companies are given in Table 15. It is observed that among top preferred activities three are from indirect AMT i.e. MRP, MRPII, and CAD, however the first ranked AMT is from administrative AMT. Similarly among the five least preferred activities, four belong to direct AMT. Thus it can be said that Indian companies are investing relatively more in administrative and indirect AMT as compared to direct AMT (Figure 8). It seems that Indian companies want to gain competitive advantage by giving more emphasis on administrative AMT compared to hardcore technology i.e. directs AMT.

Based on the above results, it seems that Indian companies follow SIA model (Figure 9) defined as Simplify (AMS) - Integrate (IIS) - Automate (AMT). This model is briefly explained below.
- Simplify: simplification of processes with Administrative AMT
- Integrate: Integration of various functions through indirect AMT
- Automate: Deploying advanced manufacturing technologies through direct AMT

It appears that Indian companies have adopted the path of improvement by following SIA model as shown in Figure 9. It is observed that Indian manufacturing companies are investing more in infrastructural issues such as administrative AMT (overall mean=3.16) and indirect AMT (overall mean=3.09). Administrative AMT helps in the simplification of systems and indirect AMT helps in the integration of information resource. Structural issues such as direct AMT (overall mean=2.50) seem to be the last item on the agenda of Indian companies.

The survey effort is followed by development of three cases to have more in-sight of manufacturing strategy issues. All the three companies ‘A’, ‘B’, and ‘C’ have definite manufacturing mission (Table 17). Based on the external and internal analysis, manufacturing mission is spelt out in line with corporate vision. To arrive at this, brain storming session involving executives from marketing, design, R & D,
finance, manufacturing etc. need to be involved. Motorbike of the company ‘C’ is quite popular in local markets. Due to excellent mileage per litre, it has 49% market share in 2 wheeler market segment. Various manufacturing strategy related attributes of these three companies are summarized in Table 18.

All companies included in the study have shown awareness towards manufacturing strategy. They have gradually changed themselves to face the fierce competition. Competitive price and quality are the common order qualifiers for the firms. Order winners for the firms are different due to product nature and product range.

The following observations are made based on the study:

1. Before the process of liberalization of Indian economy, most of the Indian managers were occupied with simply selling goods through the process. This scenario was characterized by production schedules in the face of unreliable machines, uncooperative workers, fire fighting middle level managers and shortsighted top management. The short-term orientation was due to high cost of capital, frequent government policy changes, and highly protective environment. However today the scenario is different and it is driven by competition.

2. The companies are motivated to think in long term implications. Manufacturing strategy has thus become imperative. This long term orientation is reflected in terms orga-

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### Table 15
Top Five Advanced Manufacturing Technologies

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<thead>
<tr>
<th>Rank</th>
<th>AMT name</th>
<th>AMT type</th>
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<tr>
<td>1</td>
<td>Office automation (OA)</td>
<td>Administrative AMT</td>
</tr>
<tr>
<td>2</td>
<td>Material requirement planning (MRP)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing resource planning (MRPII)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>4</td>
<td>Computer aided design (CAD)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>5</td>
<td>Computer numerical control (CNC)</td>
<td>Direct AMT</td>
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### Table 16
Five Least Preferred Advanced Manufacturing Technologies

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<tr>
<th>Rank</th>
<th>AMT name</th>
<th>AMT type</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Automated Guided Vehicle (AGV)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>2</td>
<td>Rapid prototyping (RP)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>3</td>
<td>Automated storage and retrieval system (ASRS)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>4</td>
<td>Robotics (RO)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>5</td>
<td>Bar coding (BC)</td>
<td>Indirect AMT</td>
</tr>
</tbody>
</table>
nization’s emphasis on building market share, instead of short term profits.

3. The companies have the knowledge of what needs to be done at the top level and at the operational level. The companies are adopting a strategy to have action plan in place.

The study has highlighted a number of interesting aspects of manufacturing function and strategy.

(1) In this study we have tried to map the three automotive sector companies ‘A’, ‘B’ and ‘C’ for various manufacturing strategy-related issues based on the following frameworks:
   • Competitive priorities
   • Manufacturing strategy formulation
   • Order qualifiers/order winners

(2) It is observed that manufacturing strategy seems to be linked to firms overall business strategy. Manufacturing managers are involved in the strategic formulation process.

(3) Manufacturing strategy role is significant in providing a “strategic fit” in focusing efforts and resources, so that manufacturing strategy is consistent with, and helps to support the business strategy.

Manufacturing strategy can be indeed used in a proactive manner (as evident from case ‘C’). The manufacturing comparisons are exploited to create new opportunities and markets.

Key insights gained from the study include:

1. Indian companies give greater emphasis on infrastructural issues of manufacturing strategy.
2. Manufacturing contributes to competitive success.
3. Manufacturing strategy is not limited to a few key decisions about technology, capacity; but it is defined by the total pattern of decisions across the full range of manufacturing systems.

### TABLE 17
An Overview of Indian Companies under Study

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Co. ‘A’</th>
<th>Co. ‘B’</th>
<th>Co. ‘C’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>All type of four wheeler vehicles</td>
<td>Two &amp; three wheeler vehicles</td>
<td>Two wheeler motorbikes</td>
</tr>
<tr>
<td>Sales (million US $)</td>
<td>5000</td>
<td>662</td>
<td>180</td>
</tr>
<tr>
<td>Number of employees</td>
<td>7000</td>
<td>11000</td>
<td>3000</td>
</tr>
<tr>
<td>Domestic market share</td>
<td>60% in LCVs, 72% in MCVs</td>
<td>40 % in scooter segment</td>
<td>45% in motorbike segment</td>
</tr>
<tr>
<td>Exports as % of total sales</td>
<td>30%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

### TABLE 18
Various Issues of Manufacturing Strategy in the Indian Companies

<table>
<thead>
<tr>
<th>Issues</th>
<th>Company ‘A’</th>
<th>Company ‘B’</th>
<th>Company ‘C’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing strategy formulation</td>
<td>• Formal</td>
<td>• Informal</td>
<td>• Formal</td>
</tr>
<tr>
<td></td>
<td>• VPs (manufacturing) are involved in manufacturing strategy formulation</td>
<td>• By CEO and marketing managers</td>
<td>• By CEO, President and VPs (R &amp; D, marketing, finance, and manufacturing)</td>
</tr>
<tr>
<td>Contents of manufacturing strategy</td>
<td>• High investment in AMT</td>
<td>• Use of AMT such as CAD</td>
<td>• Use of CAD</td>
</tr>
<tr>
<td></td>
<td>• Continuous improvement of manufacturing system</td>
<td>• Benchmarking</td>
<td>• Investments are consistent with business strategy</td>
</tr>
<tr>
<td></td>
<td>• High innovation rate</td>
<td>• Faster new product development</td>
<td>• Well integrated functions</td>
</tr>
<tr>
<td></td>
<td>• Focused factory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key competitive priorities</td>
<td>• Conformance quality</td>
<td>• Low cost</td>
<td>• Provide high performance products</td>
</tr>
<tr>
<td></td>
<td>• Product durability</td>
<td>• Product durability</td>
<td>• Conformance quality</td>
</tr>
<tr>
<td></td>
<td>• Provide high performance products</td>
<td>• Conformance quality</td>
<td>• Product reliability</td>
</tr>
<tr>
<td>Order winners</td>
<td>• User friendliness</td>
<td>• Brand image</td>
<td>• Excellent mileage</td>
</tr>
<tr>
<td></td>
<td>• Cost effectiveness</td>
<td>• Cost effectiveness</td>
<td>• User friendliness</td>
</tr>
<tr>
<td></td>
<td>• After sales management</td>
<td>• After sales management</td>
<td>• New product development</td>
</tr>
<tr>
<td></td>
<td>• Brand image</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Typically the SIA model followed by Indian companies is Simplify (administrative AMT) - Integrate (indirect AMT) - Automate (direct AMT)

**Implications of the Study**

**Managerial Implications**

This study provides several important implications

By building on the work of previous studies conducted in the industrialized countries, this study helps to provide a better understanding on manufacturing function and points out what manufacturing strategy means for Indian manufacturers.

The results underscore the importance of competitive priorities (such as quality, flexibility, delivery, and cost) and Advanced Manufacturing Technologies (Direct AMT, Indirect AMT, and Administrative AMT) to achieve the same.

Manufacturers can no longer be comfortable competing on the basis of one or two functional area competencies. The globalized environment requires that manufacturers have multiple competencies such as quality, delivery, flexibility, and cost.

**Implications for Academia**

The study also provides several implications for academics:

The questionnaire developed can be improved further to examine linkages with other business functions and evolving paradigms such as Supply Chain Management.

The findings of the study can act as a foundation for developing a resource based view of a particular sector.

**Limitations and Scope for Future Work**

This study has some limitations, which future researchers could consider. First, mono-respondent approach is adopted due to high cost associated with multi-respondent approach. Second, other sectors can be included in the study and/or the present sectors can be further classified (for example further classification of Automotive into vehicle manufacturers and component manufacturers).

**REFERENCES**


[한국어 요약(Korean Abstract)]

경쟁력있는 기업들은 비용절감과 품질향상을 위한 새로운 방법을 찾아내기 위해 지속적으로 노력하고 있다. 인도의 제조업체들은 이제까지 기업역량을 통한(capability-driven) 성장보다는 기회(opportunistic) 접근을 통한 성장은 더욱 중요해졌다. 따라서 지난 몇 년간의 연구에서 전략적 접근이 부족하였다. 도래하고 있는 경쟁 사나리로 속에서 이제 인도 기업들은 생산전략을 수립할 필요성을 느끼게 되었다. 이번 연구는 구조적인 질문들을 활용하여 여러 생산 전략 이슈들을 탐색적인 서베이와 3개의 케이스 스토리를 통해 평가하였다. 질문군의 최종문은 인도의 여러 지역에 위치한 150여개의 자동차 관련 생산업체들에게 배포되어 66개의 결과물(44%의 응답율)이 분석되었다. 그 결과, 우선 경쟁 요소와 잠재적인 생산 기술(AMT: Advanced Manufacturing Technology)이 확인되었고 대부분의 인도 기업들은 운영적(administrative) AMT에 가장 많은 투자를 하고 있는데 나타났다. 그 다음으로 간접적 AMT(indirect)를 통해 여러 시스템을 통합하고 마지막으로 직접적(direct) AMT를 통해 생산 시스템의 자동화를 진행하는 것으로 나타났다. 인도의 자동차 관련 기업들은 SIA모델: 단순화(simplify) - 통합화(integrate) - 자동화(automate)의 흐름을 따라가는 것으로 나타났다. 3곳의 자동차 기업의 케이스 스토리를 통해 서베이에서 발견된 사항들에 대한 검증이 진행되었다.
The development of the automobile industry plays a very important role in the national economy, not only because it is a huge industry, but the industry has a very strong effect on the related industries. The development of the automobile industry can directly drive steel, rubber, glass, chemical, electronic, and a series of related industries, and indirectly affect the petrochemical industry, road construction, car repair, tourism, and other industries.

Because of the importance of the automobile industry, many governments take the development of the industry as an important economic policy, trying to promote the development of the automobile industry to stimulate national economic development. The Chinese government is no exception, and the central and local governments have high hopes on the development of the automobile industry. Since China’s automobile industry has weathered well clearance after WTO entry, the attentions paid on China’s automobile industry have shifted to new issues. Could Chinese automobile industry grow into new export industries after clothing and household appliances industries? Could China become a new world automobile manufacturing center? This issue absorbed domestic and foreign scholars and the automobile industry public figure’s widespread attention.

As early as in 2005, some scholars began to discuss conditions for China to become a new world automobile manufacturing center. Liu, Fengzhipei, and Dong(2005) stated that there should be seven conditions for China to be a new world automobile manufacturing center. First, high-speed development and development imbalance of the world economy; Second, the appearance of a giant emerging imbalance of the world economy; Second, the appearance of a giant emerging imbalance of the world economy; Second, the appearance of a giant emerging imbalance of the world economy; Second, the appearance of a giant emerging imbalance of the world economy; Third, the advent of new production methods; Fourth, industrial shift of MNCs; Fifth, huge production and demand scale in domestic market; Sixth, openness and

Abstract - This paper studies the adjustment of world automobile industry’s production capacity, and the opportunities this adjustment will bring to Chinese automobile industry into the international market. It also analyzes the international competitiveness of Chinese automobile industry and forecasts the world’s three pillars competition pattern in automobile industry. From four aspects such as nurturing parts industries and the development of manufacturing technology, it proposes countermeasures for China to become the world car production base.

Keywords - Automobile industry, Automobile manufacturing center of the world, Restructuring of the international automobile industry, Globalization of automobile industry

Dr. Baolin Wang is a Professor of Department of Management Science and Engineering, School of Business, at Renmin University. He is on Editorial Board of Journal of Eastern Business and Economy.
(e-mail: baolin0805@yahoo.com.cn)

Jingbo Ren is a lecturer of economics at School of Economic Management, China University of Geosciences(Beijing). He completed three-year Doctral Course in Economics at Tohoku University, and is a Director of the National Society of Japanese Economic Studies.
(e-mail: renjingbo@cugb.edu.cn)

The Analysis on the Conditions for China to be a World Automobile Manufacturing Center

Abstract - This paper studies the adjustment of world automobile industry’s production capacity, and the opportunities this adjustment will bring to Chinese automobile industry into the international market. It also analyzes the international competitiveness of Chinese automobile industry and forecasts the world’s three pillars competition pattern in automobile industry. From four aspects such as nurturing parts industries and the development of manufacturing technology, it proposes countermeasures for China to become the world car production base.

Keywords - Automobile industry, Automobile manufacturing center of the world, Restructuring of the international automobile industry, Globalization of automobile industry
the extroversion of the Chinese automobile industry; Seventh, transformation from the manufacturing center into a R&D center They also think that basic conditions for the Chinese automobile industry to be a world automobile manufacturing center have been met. Above studies summarized shifting rules to be a world automobile manufacturing center. But they only analyzed external conditions for China such as economical development, market demand and so on. It is lacking in analyses on internal conditions of the Chinese automobile industry, especially those about industry international competition capacity. On the other hand, in 2003, Maruyama and Takayama(2004) began to study the competitiveness of the Chinese automobile industry, including labor cost, the mechanical device, raw material, production management of automobile assembly enterprises and so on. Useless to say, these factors are very important parts of enterprise competitiveness. But, for automobile industry, labor productivity, manufacture quality, technical ability and design quality are of the same importance. Marugawa’s study failed to mention them. Ye(2006) studied the Chinese automobile industry from industry concentration level, production scale and enterprise quantity, R&D investment, labor productivity, international trade aspects that are related to the international competitiveness of the Chinese automobile industry. But as Marugawa, it neither analyzed from the Chinese automobile industry internationalization angle, nor studied product quality, technical ability and design quality that are crucial factors to international competitiveness.

The purpose of this paper is to analyze conditions and possibilities for China to become a new world car manufacturing center, and the preparation and countermeasures to be taken by the automobile industry to become a world car manufacturing center.

**Development of the Chinese Automobile Industry and the Analysis Framework**

**Present Situation of the Development of Chinese Automobile Industry**

China’s automobile industry started from 1953, a breakthrough 100,000 in 1971, and by 1979, the output was only 185,700. China’s automobile industry underwent great development since the 1980s. In 2006, China’s automobile production reached 7.2 million, becoming the third largest automobile manufacturers, behind the United States and Japan. By 2006, although China’s automobile industry’s development pace is slower than Japan, its output has already surpassed the ROK.

The exports of China’s automobile products started late, in 2005 the exports outweighed imports for the first time, and the export volume in 2006 was 343,000, among which car exports was 93,000 (see Figure 1). China’s automobile

![FIGURE 1](source: China Automotive Industry Yearbook, China Customs Statistics)
export destinations are mainly developing countries and regions like Africa and the Middle East which have lower import tariffs, and no automobile industry.

From the above analysis, it can be seen that the development of China’s automobile industry was very quick after the 1980s. It developed to be one of the biggest automobile production countries just in twenty years or so and the scale of production has leapt to the forefront of the world. At present, China is only a large automobile manufacturer. Its domestic production merely to meet basic domestic needs, Thus still a long way to be a world’s automobile power. At present, the issue of concern of Chinese government and the automobile industry is whether China would grow into a world automobile manufacturing center, just like Japan in 1960s and South Korea in 1980s.

**The Analysis Framework of the Paper**

Early in 2005, some Chinese scholars began to explore the conditions for a new world automobile manufacturing center. The absence of the definition for “world automobile manufacturing center” caused variance in their opinions.

Here, the so-called “world automobile manufacturing center” might mean that a country’s automobile production and export volume have reached world top levels. A world automobile manufacturing center is not only an automobile production center, but also a supply (exports) center. Meanwhile, China has become a major automobile production country, but there is still a big gap between China’s automobile industry and a world’s car manufacturing center. Because China’s automobile industry is simply a supply center for Chinese domestic automobile market, and it doesn’t have large-scale export capacity to be a world’s supply center. Therefore, the core issue for China to be a new world automobile manufacturing center is its automobile industry’s exports capacity. Moreover, as China’s automobile industry started relatively late, compared with the advanced countries, there are still large gaps in quality, brand, design, etc. Large-scale exports of China’s automobile industry primarily depend on cost advantages, with economy cars entering the international market first. Therefore, at this stage, the core issue is the exports of economy car.

Theoretically, whether China’s automobile industry can export largely to the international market or not depends on its international competitiveness. However, since China’s automobile industry (especially cars) is foreign-funded enterprises, China’s automobile industry has become an important component of the world automobile industry. Multinational corporations as the center of the world automobile industry restructuring and changing in the pattern of competition have had great impact on Chinese automobile industry. We should make clear about the world automobile industry development pattern in order to study the development prospect of the Chinese automobile industry.

Based on above study, the analysis framework of the paper is showed as in Figure 2.
The Conditions and Possibilities for China to be a World New Automobile Manufacturing Center

According to the above analysis framework, in the following section, we will discuss the possibilities for China to become a new world automobile manufacturing center from the world automobile industry restructuring and the domestic automobile industry’s competitiveness.

Tendency Analysis on the World Automobile Industry Restructuring

Along with the acceleration of economic integration, the automobile companies speeded up in building overseas production base. In Toyota’s case, after the 1990s, the company raised the basic idea that “there is a need in the region for the production, jointly with the local development”. Based on this concept, the company has built thirty-nine overseas automobile manufacturing plants in twenty-four countries or regions.

Overseas investment of Multinational corporations usually has two stages. The first stage is overseas investment phase for the purpose of occupying overseas markets, building factories overseas to produce the locally required products. The second stage is for the purpose of optimizing the layout. In accordance with the principle of comparative advantage, multinational companies adjust their production capacity, re-plann functions of the branches around the world, arranging production in factories that have competitive advantages, and merging those production bases that don’t have competitive advantages on the production positions. At this stage, overseas subsidiaries having competitive advantages not only produce to meet the local market demand, but also to meet the worldwide demand.

Currently, overseas investment of the world’s automobile industry is still in the first phase with the purpose of occupying overseas market.

There are three reasons for the delay in entering into the second overseas investment phase. First, all countries in the world have high degree of protection to their automobile markets, and adjustment of the layout of the production is constrained by trade barriers. Secondly, the demand for automobile products differ in different countries, and therefore producing automobiles in the local market can better meet the needs of consumers. Thirdly, transportation costs of automobiles are quite high, therefore producing in the local market can reduce transportation costs. In light of the above three reasons, the world’s major automobile manufacturers still build factories near demanding market.

But in recent years, the world’s automobile industry is facing a change in external conditions. First, with the acceleration of economic integration, all trade barriers will be removed gradually, and protection of automobile market becomes increasingly difficult. Developing countries remain high on the protection of the automobile market and it seems hard to break trade barriers in a short time. But the automobile market in developed countries has a high degree of openness, and it has been entirely possible to supply economy cars overseas. Secondly, although the differences in consumer demand still exist, for economy cars, the consumers pay more attention to product prices. The differences in demand are smaller than the differences in high-class cars. As a result, whether China’s economy cars can export to foreign markets in large-scale and transnational corporations produce economy cars in China or not, mainly depends on the possibility of producing the same or better quality economy cars with lower cost. As long as economically viable, the automobile manufacturers will not have any obstacles in adjusting capacity.

World major automobile manufacturers mainly concentrate their efforts on reducing production costs in separation of non-advantage sectors, global procurement of components, the use of modular production methods, and so on. Along with the intensification of automobile industry’s competition, the main means of cutting costs by multinational companies will be rationalization and the adjustment of layout, and gradually transit to the second stage of overseas investment. Multinational companies will leave the production of high value-added and high-tech high-class cars in developed countries, and shift the

1) The transport cost for a car from Japan to Europe costs up to 100,000 Yen(about 7,000 Yuan).
production of low value-added and low-tech commercial vehicles and economy cars to low cost developing countries. Automobile assembly, especially low-grade vehicle assembly, belongs to labor-intensive industry, satisfying conditions to transfer to developing countries with low labor prices. Chrysler cooperates with Chery, using Chinese lower procurement costs and production capacity of Chery, developing low fuel consumption small car brand Dodge, and exports them to the U.S. market, making Chery a global supply base is the beginning of this change.

**The Analysis on the Competitiveness of Chinese Automobile Industry**

Whether China’s automobile industry can successfully use the chance of adjustment or not depends upon the industry’s competitiveness. The automobile industry’s competitiveness can usually be grasped from the production cost, labor productivity, production quality, design quality and technical ability.

**Production cost.** Since the data of manufacturing cost are inaccessible, we can use price to replace it. The comparison between Chinese and foreign car prices is always a sensitive topic and a difficult problem. Although we can not accurately compare the prices of domestic and foreign cars, but compare prices at home and abroad of same car models still have some significance.

First look at the joint venture’s product prices. According to the data on the website\(^2\), compared to the U.S. which has world cheapest car prices, prices of small cars on the domestic market has been below the U.S. market prices, domestic prices of midrange sedan are the same as the U.S. market, and domestic prices of high-grade cars are higher than the U.S. market.

Compared with joint ventures, domestic enterprises mainly compete on price. Prices of national brands such as Chery, Geely and BYD are lower than those of joint venture brands. Low production costs and product prices of domestic enterprises surprised foreign-funded enterprises. Chery can produce cars below 30,000 RMB, which has gone beyond the industry’s common sense. National brands are challenging the industry’s utmost and common sense. In production aspect, Chinese enterprises, especially domestic enterprises occupy certain advantages.

**Labor productivity.** China has more than one hundred automobile companies, and they have obvious differences in labor productivity. According to estimates, taking a car assembly plant as the unit, a joint venture vehicle assembly plant in Taiwan is about eighteen to forty-seven production per capita, while production per capita in Japan is 129, and China is only equivalent to 14-36% (Maruyama and Takayama 2004) of Japan’s. According to the investigation report released by McKinsey & Company, compared to the average labor productivity in American car manufacturers, labor productivity in China’s most efficient car production plant is only 52%, the average productivity in thirteen largest domestic car manufacturers is only 21%, and the average labor productivity in Chinese automobile manufacturing industry is only 7% of that of the U.S. as a whole.

It must be pointed out here that lower labor productivity of Chinese automobile manufacturers is directly related to factory equipment. Foreign automobile factories have already used modern equipment such as robots in welding, spraying and other phase. China’s automobile factories mainly rely on the manual work because of the cheap labor. Some of our new joint venture automobile plants basically have the same technical equipment as foreign enterprises, and labor productivity is also close to foreign enterprises.

**Production quality.** According to the year 2006 IQS, released by J.D. Power and Associates, in the section of middle and low end cars, Dongfeng Honda’s Civic ranked No.1, Shanghai Volkswagen’s Polo the second, FAW-Toyota Corolla the third. In the section of luxury cars, Guangzhou Honda’s Accord has the best quality.
Shanghai GM’s Buick and FAW-Toyota’s Reiz shared the second and the third. From the above findings, the quality of joint venture brand vehicles is better than domestic brands.

Although there is no report on car quality comparisons with other countries, the survey report says, “The quality of Chinese brands has not reached consumer acceptability in mature market. To be successful in overseas market, we must improve the quality of our automobile products. If Chinese automobiles can narrow the gap in sustainability of production quality with foreign enterprises’ level, they will be successful in the world market.”

**Technical ability and design quality**: Design quality of automobile products includes automobile performance, fuel consumption, exhaust emissions, safety and consumer’s overall perception to automobile products. As the production of joint ventures is based on the models developed by foreign side, it is difficult to judge their design quality. The “Collision door” incident encountered by Jiangling Landwind in Europe can help to judge design quality of domestic enterprises.

The ADAC had a road and crash test on Chinese pioneering exporter - Jiangling Landwind, and the result showed that Jiangling Landwind was not good in security aspects, fuel consumption and environmental protection. While some people think this is a political conspiracy of German, but the design quality and technical capability of Chinese automobile products are obviously poorer than the international standard and the gap is about twenty years.

From the above analysis, the competitiveness of Chinese automobile manufacturers varies a lot by different enterprises. Domestic-funded enterprises have greater production cost advantages, but weak in labor productivity, manufacturing quality and design quality. The joint ventures perform well in labor productivity, manufacturing quality and design quality, but the production cost advantage is not obvious.

should have international competitive advantage. Concretely, the conditions are as follows: A joint venture produces economical cars without lower quality than those made in any other economies. Moreover, the sum of production costs in China plus transportation costs to Europe, America and Japan is still less than production costs made overseas. For a domestic capital enterprise exporting with OEM, it should have the same necessary condition as joint ventures. For a domestic enterprise exporting with its own brand, it should reach the production design level as MNCs besides satisfying all above conditions.

Summarizing above conditions for China to be a world economical car manufacturing center is to have advantages of costs and quality. Therefore, in order to be a world economical car production base, first of all, China’s automobile industry must try to reduce costs, with unremitting effort. Simultaneously enterprises with national brands need to strengthen their own product designing ability.

The following part mainly makes discussions on measures for China to take off to be a world economical car manufacturing center.

**Nurturing parts industry.** One determinant of automobile production cost is factor cost. Prices of raw material and parts constitute main part of factor cost except for labor cost, energy and transportation cost and so on. In the total cost of the Chinese car assembly industry, wages occupy 8.1% only, but automobile parts, engine and its parts and some other interim products are 36.6%, 17.2% and 19.6%, respectively. In sum, costs of the three items occupy 72.4% of the total cost. From the above data, automobile industry should belong to capital intensive industry and the role of low labor prices is so limited that the focus on reducing factor cost should be nurturing parts industry. The development level of parts industry not only affects the automobile product costs directly, also is the primary factor affecting automobile product quality. Most problems that consumer may perceive concentrate on parts mainly.

At present, China’s low-attached-value, the low technical automobile parts not just satisfy the domestic needs. Moreover is has already exported to overseas market in large scales. But this certainly dose not mean that China’s parts industry has satisfy the development of the automobile industry. Nursing automobile parts industry needs to learn experiences of the electrical appliances and motorcycle parts industry being grow up to oriented to demand, make automobile parts development by automobile assembly development. We can find economy of scale in the automobile parts industry obviously. But there is no way to regulate new entrance and development of new enterprises on the ground of economy of scale. For the automobile parts industry, the role of competition is the same as that of economy of scale.

In recent years, in order to reduce the production costs, main players of the world automobile industry have started to purchase parts globally. Nursing parts industry not only makes good conditions for the industry development but also promotes exportation and globalization of the parts industry.

**Developing production methods with chinese characteristics.** Another main decisive factor of the automobile product production costs is the labor productivity, which is determined by production manufacture technology and production method. Among them, the role of production method function is more important. Looking back on the development history of automobile, there have been two significant shifts. One was between the 1920s and the 1930s. The automobile manufacture industry center shifted from Europe, automobile-birthplace to the US because Ford Motors invented the automobile assembly production-runs way (so-called Ford system), greatly reducing the automobile production costs and the prices. Second was between the 1970s and the 1980s. The automobile manufacture industry center shifted from the US to Japan because automobilists in Japan represented by Toyota company invented production methods such as Toyota’s Just-In-Time production method (JIT), and the Total Quality Control (TQC). These production methods
promoted the Japanese automobile industry production efficiency and the product quality as well. The key for America and Japan to become the world automobile manufacture bases is the production method revolution, and the production method has the decisive function in promoting production efficiency and product quality.

Considering the present situation of the Chinese automobile industry, China’s automotive manufacturing industry has some superiority in factor prices though it will be weaker considering the irreversible tendency of the labor prices rising and the appreciation of RMB. The most important means to handle the rising costs is to invent Chinese high-efficient production methods considering Chinese characteristics, with introduction, digestion, absorption of international advanced production methods.

**Mutual studying and modeling among joint ventures and domestic capital enterprises.** Joint ventures and domestic capital enterprises have their strong points respectively. Joint capital enterprises will play an important role in nurturing the Chinese automobile parts industry and introduction of production methods. At the same time, technical proliferation of joint ventures also is important technology fountainhead for domestic capital enterprises. Technology and the management style will promote technology and management through technology proliferation. It is necessary for domestic capital enterprises to learn from joint capital enterprises in various aspects such as manufacture quality, design capacity, production methods and so on. At the same time, joint ventures should also model experiences and ways of Chinese domestic enterprises to reduce the production costs as the domestic capital enterprise has superiorities in the production costs. Mutual studying and modeling among joint ventures and domestic capital enterprises is very important either in nursing parts industry or development of production methods with Chinese characters.

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[한국어 요약(Korean Abstract)]

세계 경제가 통합되면서 자동차 제조업체들의 해외 생산 또한 늘어나고 있다. 기업의 해외 생산은 일반적으로 현지 시장의 수요 증가를 위한 현지 생산과 생산 효율성의 최적화를 위한 글로벌 생산의 두 단계로 나눌 수 있다. 현재 세계 자동차산업의 해외생산은 첫 번째 단계에 머물러 있으며 외부 여건이 변화함에 따라 점차 두 번째 단계로 옮겨갈 것으로 예상된다. 이러한 조정 과정에서 중국의 자동차산업이 세계의 자동차 생산기지로 발돋움 할 수 있기 위해서는 산업경쟁력이 필수적이다. 경쟁력은 생산 원가, 노동 생산성, 품질, 디자인, 기술력에 좌우되며 토종 기업은 생산 원가에서 경쟁력을 보이는 반면, 외자 기업은 노동 생산성과 품질, 디자인, 기술력에서 경쟁력을 가지고 있는 것으로 분석된다.

향후 세계 자동차산업은 삼각 경쟁체제로 재편될 것으로 전망된다. 중국이 그 일부가 되기 위해서는 부품산업을 육성하고, 중국 고유의 생산 시스템을 개발해야 하며, 이러한 노력에 있어서 외자기업과 토종 기업의 상생협력이 무엇보다도 중요할 것이다.
Dilip Chenoy

Growth Story : The Indian Automobile Industry

Abstract - The Indian automobile industry is evolving and undergoing major transformation. From an industry which produced half a million vehicles in 1980 to an industry producing more than 11 million vehicles presently, the Indian vehicle industry has come a long way. The paper aims to highlight the Indian vehicle industry’s current performance, journey on the transformation path, factors influencing its pathway including government policies and the 21st century marking the beginning of a new paradigm.

Keywords - Indian automobile industry performance, Manufacturer, Two & three wheeler, Commercial vehicles, growth story, Automotive mission plan.

The Indian automobile industry is scripting one of the remarkable chapters in its history of evolution with nearly 40 manufacturers, producing 11 million vehicles, of which 1 million are exported, offering wide choice in models and types of vehicles and contributing to 5% of India’s GDP.

The Indian automobile industry is in upswing and is all set to become a significant global player. In 2-wheelers India is the 2nd largest producer and the world’s number one producer is located in India. India is the largest tractor manufacturer, the 5th largest Commercial Vehicle manufacturer in the world and the 4th largest Car Market in Asia.

The automotive industry is also a significant job creator, providing employment to over 10 million people. For every additional commercial vehicle produced in the country 13 new jobs are created, every additional car adds five jobs, every two - two wheelers about one job and a three wheelers around 4 jobs.

Current Indian Automobile Industry Story - Growth and Prosperity

Growth and Prosperity: Production Performance
The production by the vehicle industry for the year 2006-07 grew by 14%, domestic sales registering a growth of over 13% in number terms and more than 15% in value terms. Exports also grew remarkably with the growth rate being more than 25%. Table 1 gives the production trends in the Indian automobile industry.
Close to 1.5 million passenger vehicles, another 0.52 million commercial vehicles and 0.55 million three wheelers were produced in 2006-07. 8.44 million two wheelers were produced in 2006-07.

Domestic Market Performance

Let's us look at the unique Indian market characteristics in terms of growth of each segment in the last fiscal year, 2006-07.

The Commercial Vehicles segment was upbeat; the segment grew the most - 33% in 2006-07. This growth was led by the most important sub segment under this category, Goods Carriers or Trucks, which grew at 38%. Use of multi axle trucks is increasing. Also, in the light commercial vehicle category, a new segment sub 1-tonner mini trucks is emerging. Hub and Spoke transport system is evolving.

Passenger vehicles segment grew over 20%, with cars growing at 22%, Utility Vehicles at 13% and Multi Purpose Vehicles at 25%. In India, there is a vast choice of a large number of models to choose from, new models and share of Compact cars is rising.

In the same period, the two wheeler segment grew by over 11%. Motorcycle is the most important category under this segment.

Three Wheeler segment, which is unique to countries like India and China, grew at the rate of 12%. Table 2 indicates the vehicle sales in Indian market over last six years. The market composition, in terms of share of each segment, has remained almost same with minor changes.

Growth and Prosperity: Exports Performance

A tenth of Indian vehicle industry’s production, over 1 million vehicles, is being exported. Exports have shown remarkable performance during the year 2006-07 with the growth rate being over 25%. Last year, three wheelers exports grew the most at 87%, followed by two wheelers, commercial vehicles and passenger vehicles exports at 26%, 22% and 13% respectively.

Exports are to varied regions/ countries including countries in South Asia, EU (Germany, UK, Belgium, Italy, etc.), Middle East, North America, Russia and South Africa. Table 3 gives the Indian vehicle industry’s overseas sales.
In 2006-07, the top three destinations for different categories of vehicles were:

- Passenger Vehicles - South Africa, Algeria and Italy
- Commercial Vehicles - Sri Lanka, Bangladesh and Italy
- Three Wheelers - Sri Lanka, Egypt and Sudan
- Two Wheelers - Sri Lanka, Colombia and Bangladesh

**Growth and Prosperity: Industry-wide Developments**

The recent growth and potential for future development is recognized by the fact that almost all companies including both domestic players and global automotive groups are investing heavily in new manufacturing and assembly plants in India and have massive expansion plans. Companies have announced investment plans exceeding US $13 billion in all the segments.

The industry is keeping pace with latest developments in technology. A ten-year Emission roadmap is in place since last seven years and concerted efforts are also being undertaken to evolve a plan for the future. Safety regulations are also being developed keeping in view the country’s requirements and needs and at the same time aligning these with the international practices.

The Government of India in collaboration with industry has initiated a project dedicated solely to further the Research & Development requirement of industry called NATRIP, National Automotive Testing & Research & Development Infrastructure Project.

The industry is committed to attain global standards in technology and India has become a signatory of UN-ECE WP.29 agreement which aims at promoting global technological standards.

Further, the Indian vehicle industry is manufacturing world class products and has acquired product development capabilities. The industry is producing 100% indigenously designed vehicles and that too, at a very competitive rates. For instance, vehicles like Indica (a passenger car), Scorpio (a utility vehicle) and Jumbo (a Commercial vehicle) are designed, developed and productionized in India. The cost of development of these platforms in India is one-tenth of global cost.

**Progression of Industry - Genesis and Evolution**

The recent growth of the industry has its genesis in the development of the industry in 1960s.

**Genesis and Evolution: Pre 1970**

The Indian automobile industry’s evolution dates back to late 1960s, though some manufacturing activity was present in preceding two decades.

The first motor car and motorcycle were imported into India in 1898. For nearly 30 years thereafter, no attempt was made to manufacture or assemble vehicle in India. The first reported claim was by G Mackenzie & Co. in 1926 and it was only in 1928 that General Motors India commenced operations in India. Till 1948, the manufacture of motor vehicles as distinct from assembly was not undertaken in India. An exception being the attempt by M Visvesvaraya in the mid 1930s.

The first companies in India Hindustan Motors and Premier Automobiles were formed in 1942 and 1944 respectively. Some other firms, Automobile Products of India, Standard Motor Products of India (incorporated in 1948), Ashok Motors (now Ashok Leyland incorporated in 1948), Mahindra & Mahindra (incorporated in 1945) and Tata Locomotive & Engineering (TELCO, incorporated in 1945) submitted plans for manufacturing. In 1950, there were many importers and/or assemblers making 180 models of automobiles - 61 of cars and 119 of trucks in a market of only 20,000 vehicles. With so much competition manufacturers were forced to keep prices competitive and as such companies neither declared any dividend nor provided for depreciation of the plant or amortization of imported machinery.

In 1953, General Motors and Ford, who had established operations in India prior to 1945, withdrew from India given low levels of demand. By the end of 1955, there were six approved manufacturers Hindustan Motors, Premier Automobiles, Standard Motor Products of India, Ashok Leyland, Mahindra & Mahindra and Tata Locomotive & Engineering (TELCO).
The Indian automobile industry manufactured around 185,000 units in 1970-71 with very high vehicle prices. About a half of production was two wheelers and the remaining half was split between commercial vehicles and cars.

**Genesis and Evolution: 1970~1980**

During the Period 1970~1980, some licences were granted for the manufacture of two wheelers, in fact other than allowing some marginal increase in the numbers that could be manufactured; the new licences that were granted were among others, to Kinetic in Western India, and three manufacturers in North India LML, Majestic Auto and Scooters India. During this period, a number of joint ventures to manufacture scooters with different collaborators were issued. Subsequently many of these firms closed down as the volume of production was not optimal. Also a number of them were in the Government sector and these were later offered for privatization.

**Genesis and Evolution: 1980~1990**

The 1980’s were a significant period in the history of the automobile industry in India. Many policy initiatives were taken, and therefore many new companies, especially Joint...
ventures of Japanese companies like Maruti Udyog - Suzuki, Hero Honda, Swaraj Mazda, Escorts Yamaha, Eicher Mitsubishi, DCM Toyotae etc., entered the Indian market. New manufacturing was allowed in the two wheeler, passenger car and commercial vehicle segments. Yet there were limits of capacity for example the maximum number of commercial vehicles that any one joint venture could produce was limited by law.

As is evident from the names of the joint ventures given above, this period marked the entry of companies from Japan into the Indian auto industry.

Another related development with the entry of the companies from Japan was the beginning of a change in the auto component industry. Traditionally this industry was located in the south and the west of India.

Since, the northern region emerged as a major hub with many companies including Maruti Udyog, Hero Honda, Swaraj Mazda, Daewoo, DCM Toyota, etc. establishing their manufacturing facilities in the region, and because of their insistence that the auto component industry be located close to their production facilities, many existing companies relocated first their warehousing facilities to the north and then commenced manufacturing in the North. Further as the facility for broad banding and expansion of capacity was allowed, many existing companies expanded their facilities. For instance, Ashok Leyland manufacturing facilities were now in south, north and west of the country. Centre hub began to develop with Hindustan Motors set up another manufacturing facility in the Central region (Madhya Pradesh).

Another key development was that many of the auto manufacturers ensured that their suppliers also formed joint ventures with companies in India and set up manufacturing facilities.

Along with the then significant changes in Government policy, although in absolute terms they were not as much as industry would have liked, taxes were also gradually brought down. Maruti which entered in 1983, emerged as the market leader in the passenger vehicle segment. Hero Honda, presently world’s largest two wheeler producing company, also started developing.

With these investments, automobiles could be afforded by many and emerged as a mode of transport as distinguished from being a conspicuous product. The production increased from 568,000 units in 1980-81 to 2.2 million in 1990-91. The status of the automobile industry in 1990-91 is given in Figure 3.

Along with these developments, a regulatory structure for governing the safety features and emission of vehicles was introduced. A significant land mark was the formulation and introduction of the Motor Vehicles Act, 1988 and the Central Motor Vehicles Rules, 1989.

**Genesis and Evolution: 1990–2000**

In India, beginning from 1991, major economic reforms were undertaken. The reforms were initiated to spur economic growth and saw dismantling of restrictions on business and trade.

This liberalization provided further impetus to the auto industry with a large number of foreign manufacturers setting up base in the country. These included Daimler (DaimlerChrysler), Fiat, Ford, General Motors, Honda Cars, Honda Motorcycle & Scooters, Hyundai, SkodaAuto, Toyota, Volvo, etc.

While in the early part of the decade, most of these like Daimler Tata, Ford Mahindra, Hindustan Motors GM etc, were join ventures with India partners, most of them in the later years became wholly owned subsidiaries. Perhaps this was an entry strategy.
During this period the Government had introduced a policy of executing a Memorandum of Understanding by car manufacturers with the Director General Foreign Trade for the import of components in SKD or CKD form. 11 companies had signed such agreements. The aim was to encourage actual production of cars, develop local suppliers and promote exports.

Many new companies joined the northern hub Honda Motorcycle & Scooters, Honda Cars and Piaggio vehicles. South also emerged as a major base with setting up of manufacturing facilities by companies such as Ford, General Motors, Hyundai Motor, Tatra, Toyota Kirloskar and Volvo. The western hub also attracted lot of manufacturers like DaimlerChrysler, Fiat, General Motors, Piaggio and SkodaAuto. The emergence of these five hubs led to consolidation of existing tier I and tier II suppliers and created opportunities for new companies.

Building on the initial experience of complying with the Motor Vehicles Act, since 1991, the industry had been proactively innovating technology to ensure compliance with international standards. Many new vehicles were introduced and as a result, in 2000-01 production doubled and amounted to close to 4.5 million units. Figure 4 demonstrates the growth of automobile manufacturing firms during this period.

Genesis and Evolution: Post 2001

The year 2001 marked the year of beginning of landmark policy reforms removal of Quantitative restrictions, allowing 100 percent FDI through automatic route, doing away with foreign exchange neutralization, not insisting on any export obligation, etc. Excise duty has been progressively brought down.

In March 2002 the Government announced the Auto Policy 2002 that outlined the vision to establish a globally competitive automotive industry in India and double it contribution to the economy by 2010.

The objectives as defined by the policy included, achieving a high degree of value addition in the country, establishing a hub for the manufacture of small affordable passenger cars and a key centre for manufacturing tractors and two wheelers, assist in the development of vehicles powered by alternate energy and harmonize safety and environmental standards.

Till 2002 since the lifting of licensing in 1993, 17 new manufacturing ventures out of which 16 were for the manufacture of cars had come up.
Southern and Western region also attracted new investments.

The Indian auto industry got a further push and gained momentum, with output doubling in less than six years, with the current level being 11 million.

With these, new choices became available to consumers, financing emerged as a buying option and capacity utilization improved. Indigenously designed and developed vehicles and improvement in safety and emission standards mark the current period’s development.

Thus the industry attained new heights and this marks the beginning of a new phase of development and growth.

Figure 5 gives the current manufacturing facilities in India. This does not include some of the manufacturing facilities under construction.

Figure 6 demonstrates clearly the increase in production with the opening up of domestic manufacturing and liberalization in terms of access to technology, freedom of location, limit on number of vehicles that could be manufactured. The compound annual growth rates in 1970-80 was 10.6%, 9.9% in 1983-91, 9.6% in 1991-2001 and 16.5% in 2001-06. These growth rates clearly underline this fact.

Figure 7 also demonstrates the fact that with the liberalization of the sector, the number of manufacturers investing in India also increased. The fact that this coincided with continuous periods of high GDP growth as compared with the past perhaps could also lead to conclusions that as demand increased, the number of manufacturers increased. However in all probability the linkage with the liberalization process is stronger.

Table 4 gives the motor vehicle penetration across various countries. In 2005, while number of vehicles per thousand population in India is 16, in countries like USA, UK, etc., it is 814 and 577 respectively.

**Table 4**

<table>
<thead>
<tr>
<th>Category</th>
<th>1964</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>220.1</td>
<td>596</td>
</tr>
<tr>
<td>Japan</td>
<td>59.3</td>
<td>592</td>
</tr>
<tr>
<td>UK</td>
<td>190.9</td>
<td>577</td>
</tr>
<tr>
<td>USA</td>
<td>441.5</td>
<td>814</td>
</tr>
<tr>
<td>India</td>
<td>1.4</td>
<td>16</td>
</tr>
</tbody>
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**Genesis and Evolution: Outward Looking Approach**

Moreover, as the industry expanded domestically, it began looking for overseas markets for its products. Many companies like Hyundai Motor are establishing India as their base for exports to the world.
The vehicle manufacturers in India are fast expanding their international outreach and increasingly adopting an outward looking approach. OEMs are establishing footprints across the globe and are exploring new markets/territories. Over last five years, overseas sales have risen on an average by 40%. Exports have increased from a mere 38,000 vehicles in 1990-91 to 1.01 million vehicles in 2006-07 and are sold to discerning markets. Figure 8 demonstrates the growth in exports since 1990-91.

Passenger vehicle exports over last five years have grown at a compound annual growth rate of 49%. Figure 9 shows the growth in Passenger vehicles exports over last ten years. Hyundai Motor India and Maruti Suzuki are the two top exporters in this segment. Of this, Hyundai is the major car exporter from India. In 2006-07, 58% of passenger vehicle exports from the country were by Hyundai. Hyundai Motor India has expanded its exports sale to nearly 60 countries and is exporting to markets in United Kingdom, Malta, Serbia, Montenegro, Turkey, South Cyprus, Afghanistan, Qatar, Panama, Bermuda, etc.

**Genesis and Evolution: Factors Leading to Growth**

**Economy’s growth.** The economy’s sound fundamentals and core strengths provide a strong base for high growth of the industry.

India is a trillion dollar economy, with stable growth rate of 8~9%, rising foreign exchange reserves, market linked exchange rate regime, booming capital and financial markets and expanding domestic market with more than 70% of population being below 35 years. Indian capital market is booming with “Sensex” topping 20,000 mark. FDI flow is estimated at US$ 15.5 billion.

Around 44% of the Top 100 Fortune 500 companies are already present in India. Productivity is rising with Indian companies increasingly being globally competitive. Coupled with these, literacy level in the country is rising while at the same time poverty is declining.

**Finance availability.** With around 90% of passenger and commercial vehicle purchases financed and 70% of two wheeler purchases financed, finance availability plays a crucial role in the growth of the vehicle industry in India. Further push is provided by improved availability of finance in rural and semi-urban areas. In 2005-06, auto loans registered a growth of 75%. Favourable financing rates over the last few years have played a major role in spurring growth of the industry.

**Changing demographics.** The growing intellectual talent and availability of trained manpower at competitive cost have added to the attraction of Indian domestic market. India has a pool of high quality manpower with low prices.

In India, more than 70% of population is below 35 years of age implying huge demand potential.

In addition to these, the growth of Indian middle class with increasing purchasing power has attracted auto manufacturers to the Indian market.
Stagnation in other markets. Moreover, the increasing pull of Indian market on one hand and the near stagnation in auto sector in markets of USA, EU and Japan on the other have worked as a push factor for shifting of new capacities and flow of capital to the auto industry of India.

The increasing competition in the industry has translated into competitive prices, multiple choices and a drive to enhance productivity by the manufacturers.

Low penetration. In India, vehicle penetration is very low as compared to various other countries. The number of cars per thousand persons is only 7, a figure much lower than many of our neighbours. The figures for two wheelers and commercial vehicles are similarly lower. Given the huge growth potential, many manufacturers are attracted to the Indian market.

Wide choice. With presence of many manufacturers and resultant increased product choices for the consumers, consumers have become the leader. Increasingly new and better options are available and at competitive prices. This has boosted the market further.

Increased need for mobility. Rapid development has translated into increased needs of mobility for the Indian people. Vehicles are a source of entrepreneurship and employment for many.

Infrastructural development. Continued infrastructural development by the Government further aids the development of the industry. Highways are developed at a very rapid pace and steps are being to tackle inadequacies in the development of infrastructure.

Most importantly, concerted efforts by all stakeholders have immensely contributed to the current boom.

Automotive Mission Plan 2006~2016 - Way Forward

Last year, the Government of India launched a ten year Mission Plan for the holistic development of the auto industry in the country, Automotive Mission Plan 2006-2016. It is an endeavour of the policy makers, industry and other stakeholders to make Indian industry a world class industry.

This is not merely a policy document but a visualization of the industry’s potential and abilities. The vision is to enable the Indian auto industry

“...To emerge as the destination of choice in the world for design and manufacture of automobiles and auto components with output reaching a level of US $ 145 Billion accounting for more than 10% of the GDP and providing additional employment to 25 million people by 2016”.

Way Forward: Growth Targets

The Mission Plan takes forward the industry’s development from the Auto Policy announced in 2002 in the current global scenario. It has set a target of quadrupling the industry’s output in dollar-terms by 2016, while India’s GDP is expected to double by 2016 and doubling its contribution to GDP from 5% to 10%.

The Mission Plan envisages trebling the employment, increase industry revenue by five times and exports by nine times. It aims to retain the current position in the world as seventh largest car -manufacturer, second largest two wheeler manufacturer and fourth largest truck manufacturer in the world.

Way Forward: Identified Intervention Areas

The Automotive Mission Plan identifies 25 key interventions to realize its vision. Intervention areas identified include areas like investment attraction and promotion, encouragement to exports, development of human talent, providing conducive environment and incentivising Research & Development, development and removal of infrastructure bottlenecks, rationalization and alignment of regulations related to environment & safety, etc.

Steps are being taken to promote development in specific areas like road & vehicle safety, transport management, fuel policy, alternate technology, introduction of intelligent transport system, etc.

The Government is creating an enabling and conducive environment for the industry to flourish and sustain its development and emerge as the strength of the Indian economy.
Conclusion - Beginning of a New Paradigm

The automobile industry in India has embarked on a new growth path backed by its strong foundation, a favourable environment and growing market. The recent expansion and entry plans create more enthusiasm and optimism. The key is to sustain this confidence by embarking on the new road and at the same time, taking into account and meeting the challenges arising in this path relating to air quality, global warming, fuel efficiency, alternate fuels, safety and urbanization among others. Public transportation is another area that we need to focus on.

Entrepreneurial talent, intellectual capabilities and cost competitiveness are some of the biggest advantages of India and industry in India is poised to take advantage of this. Now, is the time for the Indian industry to work on the softer issues like quality, finish, look and create a distinctive Brand India.

A promising future beckons us; the Indian industry is proactive to discover and explore new possibilities and opportunities. Concerted efforts by all stakeholders would make the ride on this development path smoother and rewarding for all.

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