

Anna Comacchio · Giuseppe Volpato · Arnaldo Camuffo

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Automation in Automotive Industries

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# Automation in Automotive Industries

Recent Developments

With 9 Figures



Springer

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# Contents

1 Introduction.....	1
G. Volpato, A. Camuffo, A. Comacchio	
2 Industry clockspeed and competency chain design: an introductory essay.....	6
C. Fine	
3 New perspectives on automation.....	11
G. Volpato	
4 Competitive strategies, industrial models and assembly automation templates.....	31
M. Freyssenet	
5 Automation and Inertia.....	46
K. Ellegård	
6 Automation strategies at the first-tier suppliers in Japan. Process development and product trajectory. Hypothesis on the supplier-assembler relationship.....	62
H. Amikura	
7 Anticipating problems with manufacturing during the product development process.....	74
U. Jürgens	
8 Diffusion patterns of lean practices: lessons from the European auto industry.....	92
A. Camuffo, A. Comacchio	
9 The transfer of organizing principles in the world auto industry: Cross-cultural influences on replication at Opel Eisenach.....	119
J. P. MacDuffie	
10 The authors of the book.....	138

# 1 Introduction

G. Volpato, A. Camuffo, A. Comacchio

## 1.1 The background

During recent years the dynamics of automotive industry and its supply chain has catalysed the attention and the research effort of a wide international group of scholars as: the International Motor Vehicle Program (IMVP) of Massachusetts Institute of Technology, the Permanent Study Group for the Automobile Industry and Its Employees (GERPISA) of Paris, and the International Car Distribution Programme (ICDP) of Solihull. This favoured the publication of relevant studies<sup>1</sup> and the growth of networks of academicians and practitioners interested in studying the patterns of industry evolution and in organising meetings to present and discuss issues of common interest.

In 1992 some members of these research projects decided to organize a first conference in Berlin dedicated to the main theme of automation and organization in the automobile industry. In 1993 a second conference took place in Tokyo, followed by a technical visit to a few automobile manufacturers and components suppliers plants (Toyota, Nissan, Mitsubishi, etc.).

After the two conferences, the colleagues of the network invited the Department of Business Economics and Management of the "Ca' Foscari" University of Venice to organize in Italy a new conference. Thus the Third Automation Conference "Manufacturing systems and organizational paradigm in automobile industry: international patterns of diffusion" was held in Venice in October 1995. This book collects a part of the proceedings of the conference which enjoyed the attending of a vast number of international scholars and practitioners and the visit to the greenfield Fiat Auto plant in Melfi (South Italy).

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<sup>1</sup> Altshuler et al. 1984, Womack, Jones and Roos, 1990; Womack and Jones 1996, Kochan, MacDuffie and Lansbury 1996; Shimokawa, Jurgens and Fujimoto 1997, Freyssenet, Mair, Shimizu, Volpato 1998.

The papers and the case studies at the Italian Conference dealt with the relationships among automation, automobile production technology and plant organization. More specifically the main issues were:

- General Overview and Scenarios for Auto Manufacturing
- Patterns of Manufacturing and Automation Adoption
- Automation in Auto Parts Manufacturing
- Human Resource Management for Competitive Manufacturing
- Manufacturing Systems in Auto Industry: convergence or divergence?

We believe that the discussion brought forward by the three conferences and the further considerations raised by the publication of the proceedings have a manifold function. Firstly they can help to bridge research and practice in the auto industry through the exchange of ideas and experiences between the academic world and the professionals of the automobile industry involved in a huge reorganization process. Secondly they are an important opportunity to exchange points of view and present the last results achieved in each international research project, maintaining a fruitful collaboration among international scholars of the automobile industry. Finally, the subsequent research presentation and the publication of the proceedings represent a "state of the art" in the most advanced international research dealing with relationships among automation, automobile production technology and plant organization.

## **1.2 Aim of the book**

In reference to the original work of international researchers from Europe, US and Japan, the book focuses on understanding the most recent change patterns in automation, manufacturing systems, organization and management of human resources of the world automobile firms.

More specifically one important driver of the technological and organizational change is the diffusion of the "lean management system". Some researchers discuss whether or not it is the new production paradigm, but the focus of the book is rather different and it adopts a dynamic perspective. The patterns of adoption are analyzed at industry, firm and plant level and the convergent or divergent experiences are discussed.

Another relevant driver of technological and organizational change is the increasing competitive pressure that auto makers began to face in the middle of the Nineties and are facing in the last few years. Invested by the globalization process, changing product and labor market conditions as well as the economic crisis at national level, firms are striving to defend their competitive position.

In brief, even if the automation issue is one of the main focuses of this book, regarding specific technological solutions, we refer the readers to the in depth analysis of the proceedings of previous conferences. This book deals with adjustment processes underlying significant experiences. Specifically, the main aim of the book is to understand the new step of the evolutionary process which involves the manufacturing system of the automobile supply chain (automobile manufacturers and parts manufacturing firms). The drivers of this evolution are analyzed, specifically focusing on the continuous interaction among changing competitive context, new technological patterns and emerging human resource management and organizational issues.

### 1.3 Contributions

The book is organized in seven chapters. The papers included in this book, are few pieces of work selected from several significant contributions presented at the conference of Venice. In revising the papers for this book the authors took into account ideas and discussions emerged during the conference. For this reason in presenting each chapter, we wish to thank all practitioners and academicians whose participation at the conference was so fruitful.

The first five chapters of the book deal with the dynamic of automation in the automobile supply chain (Fine). This dynamic is related to the role of automation in competitive performance. In this perspective the authors consider the relationship among firm automation strategy and competitive environment (Volpato), competitive strategy and industrial form of the firm (Freyssenet), organizational and individual experiences (Ellegard), and supplier automation strategy (Amikura). The authors analyze the role of these factors on competitive performance of the firm and the convergence and divergence of the experiences.

In the first chapter the introductory essay of Fine draws the attention on the dynamic of the industries and on the importance to manage the supply chain coherently with the industry clockspeed.

According with this perspective Volpato, in the next chapter, analyses the recent dynamic of the world automotive supply chain. Volpato gives a wide overview of the most recent competitive evolution at industry level (for instance globalization, modularization of production, quality). From this perspective he analyzes the possible impact of these changes on automation strategies of auto makers and their suppliers.

In the third chapter, M. Freyssenet relies on the results of the international research program of GERPISA, carried out from 1993 to 1996, to discuss the diversities of strategies and automation templates from an evolutionary perspective. He highlights the role of history, especially in firm industrial models but also but also mismatches among industrial model, automation form and the chosen competitive strategy, to explain the divergence of firm experiences.

The paper of Ellegard deals with the individual learning process triggered by technological innovation. Ellegard studies the automation development of the Volvo Torslanda bodyshop from 1970 to 1990, considering how workers and managers previous experiences influence their approach and reaction to automation.

Amikura set a theoretical framework for a research project on automation of auto suppliers in Japan. The project is at a pilot phase. The paper discusses early results and sets the direction for future research. Based on the premise that the “tiered” structure of Japanese subcontracting is a major source of Japanese automakers’ competitive advantage, Amikura aims to explore the congruence of assembly automation of assemblers and part suppliers related to achieving the apparent trade-off between flexibility and efficiency.

As mentioned above, the approach adopted by the book is systemic and evolutionary. Improvements at automation level this way may not results in a linear predictable way. Competitive performance is related to the interaction of several factors along the added value chain and to the institutional and economic environment outside the firm.

For instance, as product cycle times reduce and time-to-market of new products becomes shorter, flexibility at production level probably needs to match the solutions adopted in previous phases, namely the product development process. Starting from this problem, Jurgens’ chapter considers issues to improve production performance by anticipating manufacturing problems during the product development process. Jurgens deals with the main approaches and organizational solutions, drawn from his research in German and U.S. car companies as part of an internationally comparative project on new product and process development networks.

The next paper by Camuffo and Comacchio adopts the same approach, considering the role of human resource management on competitive performance of the firm. The authors argue that, although automation represents a long term inarrestable trend, the search of competitiveness is tending towards continuous, but more cautious, investment in flexible automation and adoption of lean management practices at an organizational level. The authors sustain that these processes are firm specific. They argue that the firms simply do not imitate, but rather they enact a specific, contingent creative combination of firm policies and new techniques which result in a variety of technological and organizational models. Moreover, as far as the adoption process is concerned, both institutional and competitive context are important. Evidence from the European auto industry show how the “lean” concept tends to evolve as it is implemented in different contexts.

The problem of diffusion of lean management practices is one of the main focuses of the book. This issue is discussed in different papers by Freyssenet, Camuffo and Comacchio, and it is also explored by MacDuffie. MacDuffie studies the Eisenach plant, GM Europe’s most productive plant, and argue that there is a convergence towards a new dominant worldwide management model

but at the same time an increasing divergence within country and company. His research is focused on Eisenach's distinctive strategy in adopting lean management system concepts - called "replication". He considered the "template" from which Opel managers brought their experiential knowledge (CAMI and NUMMI), the means of transferring knowledge about the template to the plant (advisors, managers), then the actors (top management, plant management, engineers, workers) who took part in the learning process, and the cultural frame underlying their behavior and solutions adopted.

Many people and organization made this book possible. We express our thanks to conference sponsors: Plastal ZCP, Fiat, Fondazione Carive for their financial support that made the Conference possible, and Fiat Auto for the visit to the Melfi plant in South Italy and the Italian National Council for Research (CNR) for its conference and publication funding.

Our thanks to the conference participants and to the organization staff of the Department that helped making the Conference a most successful and enjoyable occasion.

Furthermore we express our thanks to the Springer staff, namely Mr. Lehnert and Miss. Ellewig for their support.

Finally we would like to acknowledge the fruitful discussion with our many colleagues involved in the study of the Automobile Industry and particularly the members of the International Motor Vehicle Program at MIT and the Permanent Group for the Study of the Automobile Industry and Its Employees (GERPISA) whose researches, suggestions and comments provide a stimulating environment for our studies. We express our thanks as well to colleagues of University of Venice and namely: Enzo Rullani, Sergio Faccipieri, Massimo Warglien and Stefano Micelli.

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## **2 Industry clockspeed and competency chain design: an introductory essay**

Charles H. Fine

### **2.1 Introduction and motivation**

Coping with the dizzying rate of change in the world today consumes much attention of industry and corporate leaders. Markets, technologies, and competitors all move more quickly than a decade ago and at light speed relative to a century ago. The half-lives of the leading business organizations seem to be shrinking as well, with each technological or organizational innovation unleashing another flood-tide of creative destruction. General Motors, IBM, and Sears each had their day in the sun, Microsoft is having theirs, but history provides one absolute in business as well as politics: All competitive advantage is temporary.

Although many observers have noted the need for organizational robustness in the face of economic turbulence, we have few organizing concepts to guide dynamic business strategy. This paper will introduce industry clockspeed as one such concept. Although the world may be moving faster, not all industries move at the same pace; different industries move at different clockspeeds. Furthermore, inside the firm, the different assets or capabilities may change, grow, or obsolesce at different rates. Therefore a clockspeed analysis of the firm's internal organization may yield useful insights as well.

Using the clockspeed concept as a tool, we will argue that the design and assembly of capabilities in the supply chain is the meta- or inner-core competency on which firms most need to focus. Although the business strategy literature has historically concentrated on the individual corporation as the appropriate unit of analysis, attention has now (appropriately) expanded to the extended organization, i.e., the supply chain--a term we use to mean the corporation plus its supply network, its distribution network, and its alliance network. Much of the

supply chain literature addresses supply chain management--the stewardship and utilization of the relevant network of organizations and assets to provide value to some final consumer. However, most of that literature takes the supply chain as given. Just as the manufacturing management community discovered in the past decade the enormous power of the product design activity for leverage in improving product manufacturing performance, the viewpoint here is that thorough consideration of supply chain design can reap enormous advantages for the activities undertaken in supply chain management.

Finally, we will argue that supply chain design ought to be thought of as assembling chains of capabilities for a series of temporary competitive advantages and that these design activities constitute the core of what defines a firm in a dynamic economy. Further, what distinguishes the top-performing firms from the ordinary is the ability to anticipate better where lucrative opportunities are likely to arise and to invest in the capabilities and relationships relevant to exploiting those opportunities. Risk and uncertainty are inherent in investing in hoped-for windows of opportunity, but superior market and technological forecasting ability and superior competency portfolio management are critical since, especially over the long run, fortune favours the prepared firm (Cohen and Levinthal 1994).

## 2.2

### **Clockspeed: from fruitflies and infotainment to dinosaurs and airplanes**

If an industry has a clockspeed, how might one measure it? Let me suggest several sub-metrics: process technology clockspeed measured by capital equipment obsolescence rates; product technology clockspeed measured by rates of new product introduction or intervals between new product generations; organizational clockspeed measured by rates of change in organizational structures; and "other asset" clockspeeds.

In process technology clockspeed, consider the semiconductor industry as compared to automobiles. A firm such as Intel sinks approximately a billion dollars into a wafer fabrication plant and expects that plant to be essentially obsolete in four years. If they don't get their money out in that time, they will not have the capital to build the next generation of plants. In comparison, a billion dollar engine or auto assembly plant for Ford will be expected to earn significant cash flow twenty years from now. Furthermore, Ford operates very productive twenty-year-old plants with twenty-year-old equipment. Intel has no such relies in its portfolio. Neither Intel nor Ford is necessarily sub-optimizing in this comparison, they merely operate in industries with different process technology clockspeeds.

In the domain of product technology clockspeed, consider the commercial aircraft industry compared with MICE (Multi-Media Information,

Communications and Electronics--sometimes referred to as infotainment). Boeing's rate of (major) new product launches is slightly under two per decade (777 and new 737 in the 1990's, 757 and 767 in the 1980s, 747 in the 1970's). Compare this with Disney studios. In big-release children's animated movies, Disney seems to aim for one new product per year (*Beauty and the Beast*, *Lion King*, *Pocohantas*, etc.). On a corporate basis, a major movie studio may turn out dozens of new products per year, many of which will have their artistic and economic fate sealed in the first weekend after public release. Although these products do have a long tail to their shelf life (*Snow White* is far older than the 747), Disney's product development teams presumably work on a cycle time geared to the time between new product introductions, a metric that suggests that MICE has a faster clockspeed than commercial aircraft. (More striking, perhaps, is a look at Disney's whole MICE supply chain (no pun intended): the distribution channels and technologies exhibit a very high clockspeed, where business alliances seem to form and dissipate weekly in the contest to see who can win the race for a technology-content package for two-way video, movies on demand, and infotainment.)

Regarding measures of organizational clockspeed, a few suggestive papers are Leonard-Barton (1992) who describes organizational obsolescence as "core rigidities" and Henderson and Clark (1990) who describe how firms might be unable to respond to architectural innovations in their industries due to an organizational bureaucratization around the needs of a previous technological architecture embedded in their principal products. Refining organizational clockspeed metrics will require a more thorough examination of the organizational literature.

Finally, one should consider clockspeed measurement for assets that are not explicitly process technology, product technology, or internal organizational capabilities. Two examples are distribution channels and brand names. Distribution channels such as the Sears catalog, the Walmart department store, and the internet storefront may vary significantly in the rates at which the assets can be constructed and at which they may decay. Similarly, the value of brand names such as Coca Cola soft drinks or Tide detergent may have developed over decades and may be quite durable, whereas Saturn, Lexus, and Yugo automobiles each established a strong brand image in a fairly short period of time.

Two further complexities of measuring clockspeed must also be addressed. First, aside from measuring an industry's mean clockspeed, one must consider its variance. Sturgeon (1996) has observed that both the semiconductor and the circuit board industries are reasonably fast clockspeed, but that microprocessor development has followed a low variance path as predicted by Moore's law, whereas circuit boards were slow-moving until the advent of surface mount technology, which represented a burst of improvement in the technology. Second, industry clockspeed may not be stationary in all (or any) industries. In particular, life cycle effects may exist. One could imagine an industry pattern whereby early bursts of technological discovery generate a fast pace which slows