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PART I

Setting the Stage

CHAPTER 1

High Performance Manufacturing: Just Another Fad?

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Tony Salvatori gazed out the window of his plant office in Milan, Italy, as he contemplated the events of the past few days. An American consultant had just left his office after having recommended that his plant adopt a Six Sigma quality improvement approach. With great passion the consultant told of companies in the United States that had achieved great success with Six Sigma, including such giants as Motorola, General Electric, and Seagate. While Salvatori saw the merits of this approach, he wondered if it would fit the personality of his plant. Would his engineers and managers accept the statistical methods that are required to implement the seven tools, process control charts, and design of experiments? Would these techniques actually help to improve processes in his plant? And was his plant ready for Six Sigma? Of course, the consultant had not addressed these questions but had argued that everyone should be using Six Sigma in a modern plant such as Tony's. What worked in the United States would work in Italy, too.

Today, manufacturing managers are being hit from all sides with the latest fads—from total quality management (TQM) to just-in-time (JIT) to business process reengineering (BPR) and now Six Sigma. But this book is different; we don't seek to create yet another fad. We advance the idea that the management practices leading to global high performance manufacturing differ by country, industry, and size of company, to name just a few contingencies. We take this contingency approach to adoption of management practices rather than a universal, one-size-fits-all approach. Thus, the first distinctive feature of high performance manufacturing is that it uses a *contingency approach*.

Our contention is that managers should carefully assess their unique environment and strategy before adopting the latest management practice. What works in one country and situation may not work elsewhere because of different national cultures, economic conditions, or competitive environments. Thus, to achieve high performance manufacturing (HPM), best practices must be selected and adopted relative to the situation the company faces. However, managers must not use the contingency argument as an excuse to avoid change. They should carefully study the new approaches; try them on a pilot basis, when appropriate; then determine whether the approaches should be fully deployed, or look for adaptations that might be appropriate. Rejecting new approaches out of hand is a risky business, just as is adopting every new approach that comes along.

It is well known in the academic literature that the strategy adopted and the associated practices should depend on the environment of the organization. This fact seems to have escaped many consultants and practitioners who argue that the latest management practices should be adopted by everyone. Aside from the fact that what is touted as new is not always that new after all, the advocates of universal best practices have been overselling their approaches. This had led to a series of failed initiatives and to cynicism that the latest new idea is just another fad. When viewed in a contingency perspective, it may not be that the fad failed but that management failed to apply the latest ideas in the appropriate situations. This book uses a contingency approach to provide practical advice for managers who face complex situations and who find they must select and adapt the approaches they use to their particular situation.

Returning to Tony Salvatori once again, it wasn't just Six Sigma that was bothering him. He had faithfully implemented TQM, beginning 10 years ago, and was continuing to build on his quality improvement efforts. The workforce had undergone intensive training aimed at employee involvement and teamwork. About five years ago the plant began implementing JIT by reducing setup times, stabilizing the master schedule, forming manufacturing cells, and cross training workers, to name just a few of the changes. Recently, several managers from the plant attended a seminar on enterprise resource planning (ERP). So what should Tony's next move be—enterprise resource planning, Six Sigma, or neither? Tony realized that what was also bothering him was that he had not fully linked the past practices together into a coherent whole. If he adopted one of these new ideas, how could it be linked to the practices that he already had in place? Should he concentrate on linkages when starting something new?

A second distinctive feature of this book is the emphasis we place on *linkages* among practices. We argue that linking one practice to another is what leads to HPM. It is not that success follows just from the number of practices that are implemented or from the latest practices, but from how they are related to each other and how they cumulatively build on one another. While this makes eminent common sense, managers that we have interviewed tell us that establishing and maintaining linkages across all of their new and old initiatives is one of the most challenging problems they face.

Linkage of practices provides the basis for tying new initiatives into what the plant is already doing. And integration among practices is an ongoing need that must be continually renewed. Once a linkage is achieved, it begins to deteriorate; and maintaining it requires constant attention.

But what is *linkage?* Just another slogan or is it something that is truly fundamental to management? Let's return to Salvatori's plant. He has a fully functioning quality management system, and suppose, for the moment, he wants to add Six Sigma. What would be the best way to do it? Should Tony set up a separate group of black-belt analysts who would improve processes anywhere in the plant, as the consultant recommended? Should the analysts be trained in all of the standard techniques and who should do the training? In other words how should the new program be implemented to link into the practices that already exist?

In this case Tony's plant does not have a separate quality department because this is not a common practice in his company. Rather, quality control and improvement are delegated to the line workers and engineers. Setting up a separate department or group of "black belts" would run counter to the existing plant culture and would shift attention to the staff rather than to the line responsibility for quality that already exists. Also, the plant is quite advanced in its use of statistical process control and the seven tools of quality for process improvement, but it has rarely used design of experiments to improve quality. Therefore, maybe the Six Sigma effort in Salvatori's plant should be directed at teaching design of experiments to engineers and lead workers, who would then use it to further improve processes. Salvatori could also ratchet up the rate of process improvement by using existing tools and personnel in place. This is an example of linkage of a new practice to the present situation and context. A program such as Six Sigma should not be implemented in isolation but should be linked to practices already in place. Furthermore, the application of any new program depends on the context of the plant in terms of its size, industry, and country.

THE HIGH PERFORMANCE MANUFACTURING DATABASE

A third distinctive feature of this book is that it is based on a well-defined and structured database including 164 plants around the world. We will briefly describe the data that we have collected in order to set the stage for the remainder of the book, where the data is routinely used and compared across plants and countries.

The data were collected by using a standard set of questionnaires together with site visits to many of the plants. The questionnaire packet addressed six areas of plant management practices: (1) manufacturing strategy, (2) TQM, (3) JIT, (4) human resources (HR), (5) information systems, and (6) technology management. By covering these areas, we conducted a complete audit of the plant's management practices to determine the extent of implementation of the various practices. We also measured the performance of the plant in both absolute and relative terms compared to its competitors and its global industry, and we evaluated the context of the plant in terms of its environment, size, industry, and so forth. The methods used to measure the many practices that we studied in each plant are described in Appendix 1 at the end of this chapter.

The selection of the plants to participate in the study was based on several criteria. First, about half of the plants were randomly selected from lists of "high performance reputation" plants that had been touted as leaders in the literature or by industry experts. This was done to ensure that the sample contained a good representation of some of the best plants in the world. The other half of the plants were selected at random from lists of the general population of plants. This provided a comparison group consisting of the more traditional and ordinary plants. The selection also included plants from three industries in each country: (1) electronics, (2) machinery, and (3) automobile component suppliers.

After a plant was selected to participate in the study, a member of the research team personally contacted the plant manager to request participation in the study. As a result of this personal contact we obtained a two-thirds response rate, which is quite high for a study of this type. The result of this effort is shown in Table 1.1, with the number of plants surveyed by type in each country. See Appendix 2 for a list of some of the companies included in this study.

As a result of the aforementioned efforts we have a unique and valuable database of practices adopted by manufacturing plants around the world

Table 1.1
Numbers of Plants in the HPM Study

	United States	*Japan*	*Italy*	*Germany*	*United Kingdom*	*Total*
High performance reputation	14	32	18	15	2	81
Traditional (ordinary)	16	14	16	18	19	83
Total	30	46	34	33	21	164

and the associated plant performance and context of the plants. The implementation of these practices will be examined in this book along with the linkages among practices and the context of the plants that we believe explains why a plant has adopted a particular practice in a certain way. This is the first book to provide this perspective and information for managers.

The Proposed HPM Model

The proposed model that underlies this book is described in more detail. First, we define *high performance manufacturing* as consisting of the following six practice areas:

1. Manufacturing strategy
2. Total quality management
3. Just-in-time
4. Human resources
5. Information systems
6. Technology management

This particular model is quite broad based when compared to models that have been proposed in the past. For example, Hayes and Wheelwright (1984) suggested one of the first models of high performance (or world class) manufacturing. They identified the practice areas as:

Build the skills and capabilities of your workforce.

Build technical competence through management.

Compete through quality.

Develop real worker participation.

Rebuild manufacturing engineering.

Develop breakthroughs and continuous improvement.

Their model was based on close observations of what Japanese, German, and the best U.S. manufacturers were doing at the time. Our proposed model includes all of the Hayes and Wheelwright practices and plus JIT and information systems, which were not included in the Hayes-Wheelwright model. Furthermore, we have broadened their areas of technology management, quality management, and human resources to include several more variables.

A second example of world class manufacturing is the model proposed by Schonberger (1986) and subsequently expanded by him (Schonberger, 1990, 1996). In his 1986 book Schonberger argued that world class manufacturing consisted of JIT, TQM, employee involvement (EI), and TPM (total productive maintenance). Once again, our model broadens Schonberger's notion of EI and technology management to include additional practices and adds manufacturing strategy and information systems to his list of practices.

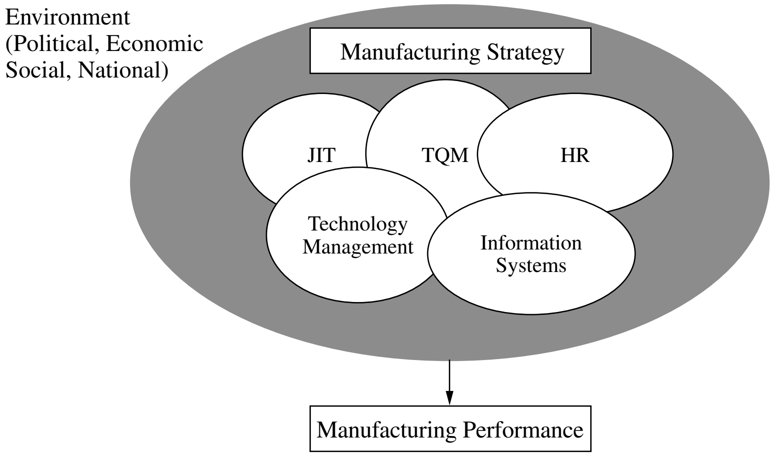
We make these comparisons not to criticize the contribution of these authors, but merely to point out the broad nature of our approach that is inclusive of many of the practices included in previous studies concerning HPM.

The linkage idea that we stress in this book can be seen in Figure 1.1, in which we indicate by overlapping circles that JIT, HR, TQM, information systems and technology management practices should be linked together. All of these practices in turn should be guided by manufacturing strategy to link the plant to its external environment. The external environment consists of political, economic, social, and national forces. These environmental forces are in constant change and require adaptation and selection of the practices used by the plant to meet the changing situation.

But what do we mean by *internal linkage between practices?* As explained earlier, it means that practices are linked together over time and that new implementations consider what has already gone before. As a result, the practices tend to reinforce each other and provide synergy. A plant that has a well-integrated set of practices guided by an overall manufacturing strategy is a joy to see in practice.

The linkage to the external environment can be thought of as the contingency approach that we have been discussing. As we shall see in Chapter 2,

Figure 1.1
HPM Model



the paths followed to HPM in different countries have varied greatly, thereby supporting our argument of contingency. The environment is a powerful force and cannot be ignored in selection and implementation of practices.

ORGANIZATION OF THIS BOOK

The book is organized into four parts. Part I begins with this introduction to our approach. In Chapter 2 we describe the contingency approach in more detail by examining the unique paths that plants in different countries have taken to achieve HPM. In Chapter 3 we discuss the linkages that must exist between practices to achieve high performance.

Part II explains the six sets of practices that constitute the content of HPM. Each chapter is devoted to one of these six sets of practices. Comparisons are made across countries, and the contingencies and linkages for each practice area are discussed.

Part III describes the practices adopted by specific countries. For example, Chapter 13 explains how small- and medium-size companies achieve high performance in Italy because there are very few large companies in Italy. As we shall see some unique adaptations of practices occur because of the size of the firms in Italy. Chapter 14 describes how the economic and political environment of Germany has affected the practices used in that country. Chapter 11 strongly supports the Japanese linkage of practices to each other.

Part IV describes some of the key findings and the future directions that we believe global HPM should take.

This book can be used in a variety of ways. We hope the book will contribute toward a greater understanding by managers of the ways in which practices should be implemented to lead to HPM in a global context. The primary purpose of the book is to enhance management practice and understanding of global manufacturing.

We also hope that the book will find its way into classrooms and libraries. As teachers of future managers, we believe that professors need teachable material that is grounded in research. While the research methods are not stressed in this book, we have written a number of academic articles that support our findings. These articles are referenced at appropriate places for the academic readers and we provide a complete listing of them at the end of the book.

REFERENCES

Hayes, Robert H., and Steven C. Wheelwright. *Restoring Our Competitive Edge*. New York: Wiley, 1984.

Schonberger, Richard J. *World Class Manufacturing*. New York: Free Press, 1986.

______ . *Building a Chain of Customers*. New York: Free Press, 1990.

______ . *World Class Manufacturing: The Next Decade*. Falls Church, VA: APICS, 1996.

APPENDIX 1

LIST OF SCALES AND OBJECTIVE MEASURES OF HPM PRACTICES

To accomplish the measurement of the practices, we first defined each of the six practice areas by a series of multi-item scales and objective questions. Each multi-item scale consisted of several perceptual questions (items) in which the scores were added to arrive at a total for the scale. For example, we measured JIT by the extent of implementation of Kanban, repetitive master scheduling, daily schedule adherence, and setup time reduction, to name a few of the scales. Each of these scales in turn consisted of several questions to provide measurement accuracy, answered on a scale of 1 to 7.

We also used objective measures in this study. For example, we asked, "What is the percentage of common parts among all products?" Another example was "the number of suppliers to the plant." The following lists describe the scales (not the items or the questions) and objective measures used in the study.

Once the questions and scales were defined, they were allocated to various questionnaires that were given to the plant manager, to several other managers, and to workers. In all, each participating plant was asked to complete a battery of 23 questionnaires, which were given to various individuals (managers, staff, and direct labor). In addition, plant visits were made to many of the plants by one or more members of the research team to observe the practices in use and to discuss them with plant management.

Manufacturing Strategy

Anticipation of new technologies

Communication of manufacturing strategy

Formal strategic planning

Functional integration

Note: Each of the scales and measures includes several questions that are available from the editors.

Long-range orientation
Manufacturing-business strategy linkage
Manufacturing strategy strength
Product competitive performance comparison
Proprietary equipment

Total Quality Management

Continuous improvement
Customer involvement
Customer satisfaction
Feedback
Maintenance
Process control
Quality in new products
Rewards for quality
Supplier quality management
Top management leadership for quality
TQM link with customers
Quality approach
Supplier quality level

Just-in-Time

Accounting adaptation to JIT practices
Comakership
Daily schedule adherence
Equipment layout
JIT delivery by suppliers
JIT link with customers
Kanban
Material requirements planning (MRP) adaptation to JIT

Pull system support
Repetitive nature of master schedule
Setup time reduction
Small lot size
Fixed production schedule

Human Resources

Centralization of authority
Commitment
Coordination of decision making
Pride in work
Compensation for breadth of skill
Documentation of shop floor procedures
Employee suggestions
Incentives for group performance
Management breadth of experience
Manufacturing/human resource fit
Multifunctional employees
Recruiting and selection
Rewards/manufacturing coordination
Shop floor contact
Small-group problem solving
Stable employment intention
Supervisory interaction facilitation
Task-related training for employees
Worker's breadth of job
Compensation ratio
Compensation/rewards/incentives
Egalitarian index
Employee turnover
Training

Information Management

Accounting
Benefits of information systems
Coordination with corporation
Dynamic performance measures
External information: supplier quality control
Internal quality information
Management vision of information technology (I.T.)
Manufacturing plans
Performance feedback
Stability/predictability of short-term production
Applications of I.T. and architecture
Future expenses
Information for JIT suppliers and customers
New accounting systems
Seven tools
Shop floor planning and control technique
Software architecture
Telecommunications systems

Technology Management

Effective process implementation
Interfunctional design efforts
New product introduction process
Product design simplicity
Working with technology suppliers
Automation level
New product introduction cooperation
Willingness to introduce new products
New product development

Plant Performance

Competitive performance on cost, quality, delivery, and flexibility
Accounting data on costs, scrap, rework, on-time delivery, and cycle time
Cost of poor quality

Plant Environment

Complexity of environment
Plant description
Plant focus
Products, parts, and processes
Industry and country

APPENDIX 2

This appendix contains the names of some of the companies/plants that participated in the study. One plant from each of these companies was selected for data collection. The names are listed to illustrate the types of companies that are included in the data set.

United States

Aisin USA Manufacturing, Inc.
Calcom
Caterpiller
Douglas Autotech
Dowling Engine Cooling (Valeco)
Duff Norton
Eaton Corporation
Exide Electronics Corporation
Extrude Hone
Gates Rubber Company
Henry Filters
Honeywell
Hutchinson Technologies, Inc.
Indresco
Intergraph Corporation
John Deere
Komag, Inc.
Prince Corporation
Roper Whitney of Rockford
Signet
Stanadyne
Stone Construction Equipment, Inc.
Telex Communications, Inc.
Tennant
Texas Instruments
Tower Automotive
Unisys
United Technologies Automotive
Verbatim Corporation
ZF Industries, Inc.

Japan

Aisin AW Industries Company Ltd.
Akebono Brake Industry Company Ltd.
Amada Company Ltd.
Anest Iwata Corporation
Casio Computer Company Ltd.
Chuomusen Company Ltd.
Darkin Industries Ltd.
Fujitsu Limited
Hitachi Construction Machinery Company Ltd.
Hitachi Ltd.
Honda Motors Company Ltd.
Ishikawajima-Harima Heavy Industries Company Ltd.
Isuzu Motors Ltd.
Keeper Company Ltd.
Komori Corporation
Kubota Corporation

Kuroda Precision Industries Ltd.
Makino Milling Machine Company Ltd.
Mazda Motor Corporation
Mitsubishi Electric Corporation
Mitsubishi Motors Corporation
NEC Corporation
Nihon Kohden Corporation
Nippondenso Company Ltd.
Nissan Shatai Company Ltd.
Omron Corporation
Sony Corporation
Tadano Ltd.
TDK Corporation
Toshiba Corporation
Toshiba Machine Company Ltd.
Yokogawa Electric Corporation
Zexel Corporation

Italy

Alcatel Telettra S.p.A.
Asem S.p.A.
Bull Itailia S.p.A.
C.AR.EL S.r.L.
Calearo S.r.L.
Carraro S.p.A.
Comau S.p.A.
Dataconsyst S.p.A.
Diavia S.p.A.
F.A.I. S.p.A.
Ferroli Industre Riscaldamento S.p.A.
Fiam Filter S.p.A.
Gate S.p.A.
I.R.C.A. S.p.A.
IBM Semea S.p.A.
Ina Rullini S.p.A.
Lombardini S.p.A.
Mandelli S.p.A.
Marposs S.p.A.
Marzorati Tecnica Industriale S.p.A.
Otis Italia S.p.A.
Prima Industrie S.p.A.
Riva Calzoni S.p.A.
S.I.L. Met S.p.A.
S.M.A S.p.A.
Saes Getters S.p.A.
SAFOP S.p.A.
SCM S.p.A.
Seima Italiana S.p.A.
Seleco S.p.A.
SGS Thomson S.p.A.
SIT S.p.A.
SIV S.p.A.
Valeo S.p.A.