HOW ARE THE NPD PRACTICES IN THE HIGHEST PERFORMING COMPANIES?

Bjørge Timenes Laugen[1], Eric Christian Brun[2], Nuran Acur[3], Harry Boer[3], Jan Frick[2]

[1] Stavanger University College, Centre for Maintenance and Asset Management
P.O. Box 8002, N-4068 Stavanger, Norway
bjorge.laugen@tn.his.no

[2] Stavanger University College, Business and Administration Department
P.O. Box 8002, N-4068 Stavanger, Norway

[3]Aalborg University, Centre for Industrial Production
Fibigerstræde 16, DK-9220 Aalborg Ø, Denmark

ABSTRACT

During the last 20 years both industry and academia have searched for World Class Manufacturing and tried to define 'best' practices aiming to increase the companies' performance or to stay competitive. However, many of these studies are problematic because the practices that are considered as best often are predefined and the link to the actual overall company performance is often not investigated.

This paper identifies the highest performing manufacturing companies based on the IMSS database, and investigates the practices that these companies have within manufacturing and NPD and compare this with the lowest performing companies. The result indicates that NPD practices are strongly linked to improvement of the operational and the overall company performance.

Keywords: Best practices, manufacturing strategy, new product development

INTRODUCTION

Manufacturing companies are exposed to ever greater competitive pressure. They need to be and stay, or become among the best-in-class in order to survive. Both industry and academia have put a lot of effort into identifying knowledge, processes and tools that can be labelled as best practice. Many authors maintain that continuous identification of 'best practice' in all areas in the organisation will lead to superior performance and capability resulting in increased competitiveness. New product development (NPD) has gained increased importance among manufacturing companies during the last years, and new products represent an increasing amount of the total turnover in companies. As a consequence of this, time to market, broad involvement of actors in the development process and manufacturability is gaining increased importance.

An important issue in this discussion is what the best companies are doing considering NPD practices. There is reason to believe that there are several lessons to be learned from the highest performing companies and their practices within NPD.

This paper will try to identify the NPD practices that the highest performing companies have. We will refrain from using the term 'best NPD practices' for reasons that will be elaborated further in this article. Our approach is turned the other way around compared with previous 'best practice'-studies, which often define 'best practices' before the analysis starts and compare to what extent other companies have the same practices in place. We believe that although a number of defined NPD practices can be commonly viewed as favourable, what constitutes the most beneficial approach to manage NPD processes within a company depends on a number of situational and strategic factors. We think that the approach put forward in this paper can add knowledge into the debate considering best practices and the link to overall company performance.

This paper will put forward a first attempt to address the question: how can we determine *highest performance* and, then, are *NPD practices* related to best performance?

BACKGROUND

The 'best practice' approach to manufacturing strategy has emerged with the Japanese companies' extraordinary process and product improvement success. Western industry began to look at Japanese companies' achievements in order to apply some of the principles used in Japanese industry to Western industry. Best practice achievement has since become a driving force amongst industry. The best practice approach to manufacturing strategy encapsulates the 'World Class Manufacturing' (WCM) philosophy and benchmarking, with the assumption that:

'The continuous improvement of 'best practice in all areas of the organisation will lead to superior performance capability leading to increased competitiveness' [1].

The theoretical background for this paper will partly be on general movements within the NPD theory during the last years and partly a general overview over best practice and World Class Manufacturing (WCM) studies

NPD development

The new product development (NPD) process has gained increased importance during the last years. This, among other reasons, is because the life-time of many products has been shorter while new products are launched more frequently. New products are now representing a higher degree of the income in companies today than a few years ago [2]. With the increasing pressures of global competition, innovation has become increasingly important, which has led to an increasing awareness and sophistication of NPD methods [3-8]. It is argued however, that many existing NPD methods are being found insufficient to meet new demands that are emerging from this development. For example, the increasing need for innovation has revealed that many existing NPD methods are not well suited to manage NPD processes of radically innovative nature [3, 9]. Also, while the usefulness of using partnerships, networks or alliances in the NPD process is generally recognised [6-9], it does not appear to be clear how existing methods help a company manage the issues that emerge when conducting NPD efforts with alliance partners.

An interesting line of thought that is emerging is therefore that the most beneficial NPD practice for a particular company may be one that is effectively adapted to the company's situational and strategic context [10-12].

World Class Manufacturing

Hayes and Wheelwright [13] introduced the term World Class Manufacturing, and described this as a set of practices, including quality management, continuous improvement, training and investments in technology. The implementation of these 'best practices' would lead to superior performance [14].

Schonberger [15] argued that many lessons could be learned from Japanese manufacturing industry. He regarded improving the material flow in the production as one of the most important issues, and the flow could be improved through implementing Just-in-Time, Total Quality Control and Total Preventive Maintenance. In addition, still according to Schonberger, WCM means continual and rapid improvement in all areas of the company, and training is the catalyst for that [15].

Flynn *et al*. [16] investigated how different innovation programmes have been implemented, the influence of quality management practices on quality performance and the interrelationship between JIT and quality management. However, their study, which followed from the World Class Manufacturing project, was primarily limited to investigating the separate practices' influence on the (separate) performance criteria, and the study does not offer a holistic perspective either on practices or performance.

'Best practices' – a constraining term

In the studies Made in Europe, Made in Switzerland and Made in Britain, WCM is characterised by both good practices as well as good performance [17]. To be world class the companies should have best practices, and continuous development and improvement of best practices in all areas within a company: total quality, concurrent engineering, lean production, manufacturing systems, logistics and organisation [18, 19]. In these studies, linkages are found between implementation of the 'best practices' and improved performance.

The basic principle of the best practice thinking is that operations philosophies, concepts and techniques should be driven by competitive benchmarks and business excellence models to improve an organisation's competitiveness through the development of people, processes and technology [1, 20]. In these studies techniques like JIT, TQM and EFQM are defined as 'best' practices and these are assumed to imply improved performance. However, these studies only rarely link the best practices to the performance of the companies.

At best, a link between best practices and performance is *assumed* [19], or (implicitly) considered self evident [21], even if some studies confirm that use of 'best' practices leads to improved performance [18, 21]. And if an explicit link is made, this is done only within limited performance criteria; for example, the implementation of quality programs leads to increased quality performance [22].

Another weakness of the "Made in …" studies is that they do not take into consideration that other practices, or configurations of practices, might be even more important for the overall performance of the companies than the predefined 'best' practices. There may be companies that are not reaching 'world class'-status, due to the definition of best practices in these studies, which are really world class performing, but have implemented another set of practices to reach the level of performance.

Another critique of the definition of best practices is that the model is made universal for the whole manufacturing industry, and not adapted to factors like type of industry, company size, processes and products. There is reason to believe that the degree of use of the different practices will differ significantly depending on these contingencies. In addition, little effort is put in these studies to analyse the relationship between the different

practices and to address which of the practice(s) that are the most important for the overall performance.

Research questions

Most of the theories about NPD have primarily been focusing on different issues by considering methods, tools and best practices only within the NPD process. Few empirical studies have been done to relate between NPD performance and the total performance of the company. In addition, there has been given little attention to investigate whether the companies with a good NPD process do also have good overall performance.

The main purposes of this paper are to:

- Define the best overall performing companies, based on Return on Sales (ROS), which is a financial performance criteria measuring the current status for the companies' profitability.
- Investigate what, if any, are the common characteristics of the best performing companies? Characteristics should be analysed both on the firm-level, i.e. size, process types and contextual, i.e. market development, customers
- Investigate how are the NPD practices in the highest performing companies?
- Does implementation of NPD practices lead to improved manufacturing performance, e.g. reduced manufacturing lead time, increased customisation and increased quality.

METHODOLOGY

The paper is based on the 2002 International Manufacturing Strategy Survey (IMSS-III) database, which contains data from 474 manufacturing companies from 14 countries, shown in Figure 1. IMSS is a co-operative research network of business schools, whose aim it is to develop, maintain and analyse using a variety of perspectives and research questions, a global database for the study of manufacturing strategies, practices and performances.

We assume that practices and performance in manufacturing companies are to a large extent dependent on industry type and company size. Thus, we divided the respondents into five groups of industry type and then in three size categories: small – up to 100 employees, medium – up to 250 employees and large – more than 250 employees. These

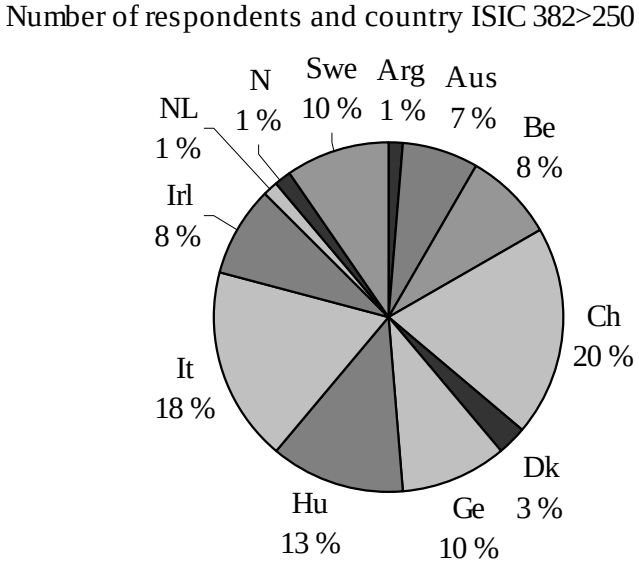

Figure 1 – Respondents in the IMSS III, ISIC 382 (machinery), more than 250 employees, N = 72

categories agree with the categories used by e.g. the EU. The grouping of the respondents is shown in Table 1. The further analyses in this paper will be based on the manufacturers of *machinery equipment* (ISIC 382) with more than 250 employees. This is partly due to a need for limitation in this paper and partly because several of the groups include too few respondents to be a basis for analysis.

We define the best performing companies within this sample from a financial profit perspective only. Ten companies are defined as the best performing companies, and another ten as the lowest performing, based on the 80 % percentile, respectively 20 %, of Return-on-Sales (ROS). As we show later in the paper, we found significant correlations between the ROS and the action programmes or manufacturing practices of these companies. In contrast, additional analysis, not included in this paper, carried out on all the companies in ISIC 382, and on the companies smaller than 250 employees, showed no significant correlations between the ROS, and the action programmes or manufacturing practices of these companies. This indicates that the standard deviation in degree of implementation of practices among the small and medium sized companies is bigger than among the large companies. In addition, an analysis based on the whole IMSS III-sample gives weaker relationships and levels of significance relative to those found in the large ISIC 382-companies. This indicates, not surprisingly, that both company size and industry type does affect the relationships between manufacturing practices and performance.

	Company size			
Industry type (ISIC)	-100	101-250	251+	Total
Metal products (381)	47	56	35	138
Machinery (382)	30	47	**72**	149
Electrical equipment (383)	16	26	65	107
Transportation equipment (384)	7	4	33	44
Professional equipment (385)	3	18	15	36
Total	103	151	220	474

Table 1 – Number of respondents distributed in industry type and company size

ANALYSIS

The analyses in this paper starts with defining the best performance companies and an investigation of the main characteristics of these companies. Thereafter these companies' manufacturing practices are investigated and finally these practices' influence on performance *improvement*.

What are the characteristics of the highest performing companies?

The average size of the highest performing companies is 3000 employees, which is higher compared with the lowest companies, where the average size is 565 employees. However, there is no significant correlation between size and ROS.

In addition, the highest performing companies seem to be operating in faster growing markets, with higher fluctuations in demand (corr 0,62** with ROS) and are exposed to more customers (corr 0,32* with ROS) than the lowest performing companies. This indicates that the highest performing companies are operating in a quite challenging market situation.

The highest performing companies are primarily competing on *quality* (conformance and design) and *delivery* (reliability and speed). These issues are also important for the lowest performing companies, however, with *price* as the third most important competitive priority.

What are the action programmes and practices of the highest performing companies?

As Figure 2 shows, updating *process equipment* (score 3,9) and expanding *manufacturing capacity* (3,9) are the most used action programmes among the highest performing companies in the last three years. *Quality improvement (e.g. TQM), process focus, workplace development* and *equipment productivity (e.g TPM)* are also used to a high degree. Improving NPD practices is approximately of medium degree of use compared with the total configuration of practices. The lowest performing companies make less use of all the action

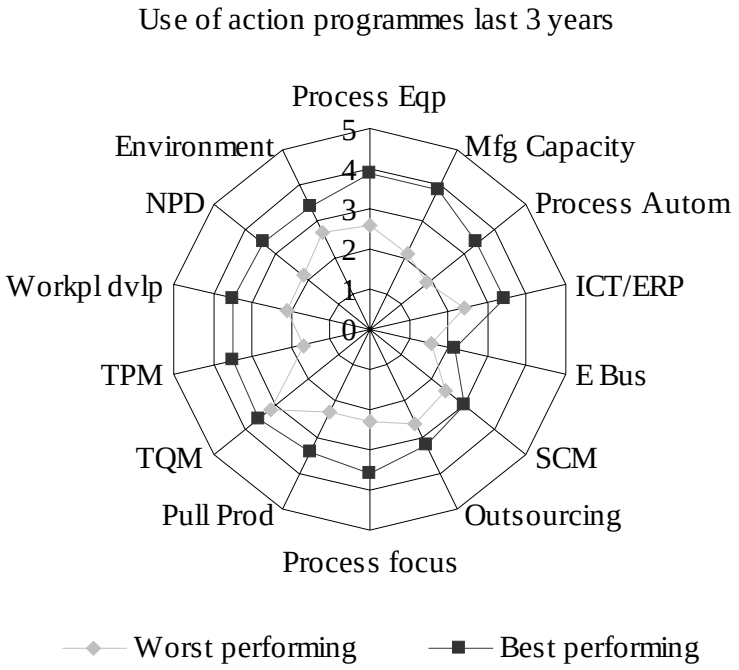

Figure 2 – Use of action programmes last 3 years among the highest and lowest performing companies, ISIC 382 companies more than 250 employees, N=72. (1 = no use, 5 = high use)

programmes investigated.

As Table 2 shows, 6 of the 14 action programmes are strongly and positively correlated with ROS. This confirms the findings shown in Figure 2, however, with *process automation* and *expanding manufacturing capacity* as the action programmes with the strongest relationship with ROS. Use of NPD programmes are also quite strong correlated with ROS, that indicate that the companies that are having a large effort in NPD practices during the last three years have high ROS. However, it is not possible to state a cause-effect-relationship, meaning if NPD practices lead to improved financial performance, or if the profitable companies only are putting more effort into NPD without any significant

ISIC 382>250	**ROS**
Manufacturing capacity	0,452
Process automation	0,454
Process focus	0,303
Equipment prod (TPM)	0,323
Workplace development	0,334
NPD	0,298
Training regular employees	0,418
Inv in process equipment	0,404

Table 2 – Correlations between action programmes/ practices and ROS for ISIC 382 >250 employees. All significant at 0,05-level.

effect on ROS.

Table 3 indicates that the highest performing companies to a larger extent than the lowest are using *meetings* to coordinate design and manufacturing. In addition, early *involvement* of manufacturing in the NPD processes and *concurrent engineering* is also used to a larger extent among the high performing companies to manage the NPD cycle.

	Highest performing	Lowest performing
Coordinate design-manufacturing		
Rules	4,5	4,1
Meetings	4,1	2,9
Multiskilled	3,2	3,3
Job rotation	1,8	1,6
Manage NPD cycle		
Mfg involvement	3,7	3,3
Conc engineer	3,9	3,3
Prototype	3,2	4,5
Change orders	3,6	2,9

Table 3 – NPD practices among the highest and lowest performing companies (1 = no use, 5 = high use).

Do the NPD practices lead to improved manufacturing performance?

Implementation of action programmes that aim to increase *equipment productivity* (e.g. TPM) and to improve *New Product Development processes*, seem to relate to the largest amount of manufacturing performance indicators, as shown in Table 4. The companies with large extent of practices implemented to increase *equipment productivity* have increased performance in several areas, i.e. quality, lead time, productivity and capacity utilisation. The companies that have implemented practices regarding improvement of *NPD processes* have increased performance within i.e. quality, customisation, time to market, delivery speed, lead time and productivity. This indicates that NPD improvement practices are related to improving several of the most important manufacturing performance criteria.

		Use of action programmes last 3 years				
	ISIC 382 >250 employees	Mgf cap	Proc autm	TQM	Eqp prd (TPM)	NPD
Manufacturing perform indicators	Mfg conform	0,304	0,243			
	Prd quality		0,355	0,467	0,263	0,279
	Customisation				0,280	0,319
	Vol flexibility				0,348	
	Mix flexibility			0,251	0,315	0,335
	Time 2 market					0,351
	Service		0,353	0,255	0,266	0,277
	Deliver speed					0,247
	Del reliability					0,335
	Mfg lead time	0,250			0,298	0,299
	Prc lead time			0,252		0,258
	Procure cost					0,337
	Labour produc	0,349	0,467		0,484	0,423
	Cap utilisation	0,269	0,353		0,398	

Table 4 – Correlations between action programmes and improvement of manufacturing performance. All significant at 0,05-level

As Table 5 shows, use of *meetings* and *job rotation* to coordinate design and manufacturing and *early involvement* of the manufacturing function are positive correlated to improve several manufacturing performance criteria. This supports the findings shown in Table 4.

ISIC 382 > 250 employees		NPD practices		
		Meet	JobRotat	Involvm
Mfg performance indicators	Quality		0,352	
	Customisation		0,245	
	Time 2 Market		0,285	
	Service	0,271		
	Delivery speed	0,247		
	Procurem cost		0,293	0,285
	Labour produc	0,334		
	Cap utilisation			0,248
	Overhead		0,322	0,349

Table 5 – Correlations between NPD practices and improvement of manufacturing performance. All significant at 0,05-level

DISCUSSION

As the analysis shows, few groundbreaking findings have been developed through this paper. Several of the practices that the highest performing companies are using, are the well-known 'best' practices defined by among others [19]. This indicates that the practices that were in use ten years ago still are in use and still are strongly related to the company performance.

Our analysis indicates that some of the new/emerging practices also are used, e.g. TPM and NPD programmes, and that these practices are significantly related, both to operational and financial performance. Unfortunately, the questions formulated in the questionnaire are too broad to say to if there are *sub-practices* within the upcoming practices that are most influential on the performance, e.g. concurrent engineering or 5S. Further development of the questionnaire is necessary if the influence of the sub-practices should be addressed.

Another issue that is not discovered in this paper is to what extent the performance of the best companies are due to practices or factors that are not asked for in the survey. There are no open questions in the questionnaire. Organisational culture and network relationships are among the issues that can have a considerable effect on the performance but these factors were not asked for in the survey.

As mentioned earlier in the paper, we chose ROS as the indicator for company overall performance. ROS gives an impression of the current financial performance/profitability of the companies. The ROS consists of two central elements: cost and price. The price element is primarily dependent on the type of industry and the market that the company operates in. As mentioned earlier, price is not among the most important competitive priorities for the best companies, but the third most important for the lowest performing. This difference can partly be explained by that the highest performing companies are operating in *growing markets*, while the lowest performing companies are operating in mature markets. In mature markets, price becomes more important as a competitive priority. The cost element is depending on an efficient production and can be largely influenced by the different practices that are implemented. Practices that are largely used by the highest performing companies, i.e. upgrading process equipment, process automation, process focus, TQM and TPM, are significantly related to the manufacturing performance.

The highest performing companies are putting significant higher effort into practices considering manufacturing capacity than the lowest performing companies. This is not surprising taken into consideration, again, that the best companies investigated in this paper are in growing markets. Practices related to growth are primarily updating the process equipment, quality programmes and expanding manufacturing capacity.

Several of the most influential practices seem to be *improvement* related. Among these are NPD programmes and various programmes to increase productivity, e.g. TPM and TQM. This indicates that the best companies are more committed to continuous improvement activities.

Important to notice is that implementing actions to speed up the NPD process are linked to improvement in more manufacturing performance indicators than all the other investigated action programmes. In addition, coordination of manufacturing and design through *meetings* and *job rotation*, and early involvement of manufacturing in the NPD process are also quite strong correlated to improvement of manufacturing performance indicators, e.g. quality, time-to-market and customisation. However, it is not possible from these analyses to say if the improvement in manufacturing performance is due to the various NPD practices, or in other ways try to indicate a cause-effect relationship between NPD and manufacturing performance.

As shown earlier in the paper, the best companies are putting more effort into all the investigated practices and action programmes compared with the lowest performing companies. This indicates that it is the *configuration* of several practices that gives the significant difference in performance between the highest and the lowest performing companies, and not large effort or excellence in one or two practices. The main reason for this is that the companies are doing a lot of different processes and have to manage various market demands, e.g. quality, deliveries, growth and service. To solve this, various practices, techniques and technologies are necessary to implement and improve. The best companies seem to have a configuration of practices that are considering effective/efficient production (investments in technology, training, quality and maintenance) as well as innovation (NPD). The various NPD practices are therefore a part of the total configuration of practices that are carried out within manufacturing companies. However, the various NPD practices seem to be strongly linked to both improvement of manufacturing and the overall company performance.

The analyses in this paper are exposed to some methodological problems due to the data/questionnaire that has been used. First, the majority of the analyses are based on questions requiring the respondents to answer on a 1-5 scale. These scales are attended with some methodological problems compared with questions that asking for an absolute value, as perception rather than fact comes into play. Second, the respondents' practices are based on a question considering the degree of use of different action programmes during the last three years. These action programmes can be seen as sub-configurations of practices. However, the question is not asking about the *extent* to which the practices have been implemented and disseminated in the organisation, only about the effort put into their implementation. Furthermore, there is usually a time lag between the implementation of practices and their effect on the performance.

CONCLUSION AND FURTHER RESEARCH

The findings in this paper seem to confirm existing knowledge in the area of best practice studies. We find that well-known practices like TQM are widely used among the highest performing companies. In addition, some emergent practices are also used to a large extent, which shows that the best companies are good at implementing up-to-date methods and techniques. Among those practices, continuous improvement programmes are the most widely used and the most effective practices for the highest performing companies.

The results of the analysis show that the highest performing companies are using all the investigated action programmes to a higher extent than the lowest performing. This indicates that it is necessary to implement the whole *configuration* of practices to have a good overall performance, and that the holistic view on use of practices and performance is the largest difference between the highest and the lowest performing companies.

The highest performing companies seem to put more effort into implementing action programmes to speed up the NPD process than the lowest performing companies. In addition, early involvement of manufacturing in the NPD process and concurrent engineering is used to a higher degree among the highest performing companies. However, there are relatively small other differences between how the highest and lowest performing companies are managing the NPD and coordinate design and production.

The analyses performed for the purpose of the present paper also suggested several areas of further research. One of these is to define the highest performing companies from a broader set of business performance criteria e.g. ROI, market share, sales/employee, in addition to ROS, and to see how these performance aspects are affected by manufacturing practices and action programmes.

In addition, there is a need to investigate deeper the *configurations* of practices, the relationships between the practices and the impact of separate practices *and* of the total configuration, on the overall performance. Through this the most influential practices can be investigated. Another question regards the relationships between performance and practices within other industries than manufacturing of machinery equipment (ISIC 382). Furthermore, company size seems to influence the adoption and effectiveness of practices. Further analysis is needed to say to what extent the practices used by the highest performing larger companies also are usable in and effective for the small and medium sized companies.

The analysis in this paper is primarily based on bivariate analysis and descriptive statistics. We cannot exclude the possibility that some of the findings or effects from variables actually are from other variables that we have not controlled for. This means that analysis based on more advanced statistical methods should be carried out to clarify to what extent the different independent variables are influencing the dependent variable, i.e. Return-on-Sales.

REFERENCES

1. Voss, C.A., *Manufacturing strategy - Process and content.* 1995: Chapman & Hall.
2. C Shepard, P.A., *NPD Frameworks: A Holistic Examination.* European Journal of Innovation Management, 2000. **3**(3): p. 160-173.
3. Poolton, J., *New Developments in Innovation.* Journal of Managerial Psychology, 2000. **15**(8): p. 795-811.
4. Nijssen, E.J. and K.F.M. Lieshout, *Awareness, use and effectiveness of models and methods for new product development.* European Journal of Marketing, 1995. **29**(10): p. 27-44.
5. Griffin, A., *PDMA research on new product development practices: Updating trends and benchmarking best practices.* Journal of Product Innovation Management, 1997(14): p. 429-458.
6. Pilkington, A., *Strategic alliance and dependency in design and manufacture.* International Journal of Operations and Production Management, 1999. **19**(5/6): p. 460-473.
7. Ozer, M., *A survey of New Product Evaluation models.* Journal of Product Innovation Management, 1999(16): p. 77-94.
8. Rothwell, R., *Towards the Fifth-generation Innovation Process.* International Marketing Review. **11**(1): p. 7-31.
9. Veryzer, R.W., *Discontinuous Innovation and the New Product Development Process.* Journal of Product Innovation Management, 1998(15): p. 304-321.

10. Loch, C., *Tailoring Product Development to Strategy: Case of a European Technology Manufacturer.* European Management Journal, 2000. **18**(3): p. 246-258.

11. K A Weir, A.K.K., S A LeBeau, D G Edgeley, *An Empirical Study of the Alignment Between Manufacturing And Marketing Strategies.* Long Range Planning, 2000(33): p. 831-848.

12. W E Souder, J.D.S., R Davies-Cooper, *Environmental Uncertainty, Organizational Integration, and New Product Development Effectiveness: A Test of Contingency Theory.* Journal of Product Innovation Management, 1998(15): p. 520-533.

13. Hayes, R.H., Wheelwright, S.C, *Restoring our competitive edge - competing through manufacturing*. 1984, New York: John Wiley.

14. Flynn, B.B., Schroeder, R.G. and Flynn, E.J., *World class manufacturing: an investigation of Hayes and Wheelwright's foundation.* Journal of Operations Management, 1999. **17**: p. 249-269.

15. Schonberger, R.J., *World Class Manufacturing: The Lessons of Simplicity Applied.* 1986, New York: Free Press.

16. Flynn, B.B., Schroeder, R.G., Flynn, E.J., Sakakibara, S. and Bates, K.A., *World class manufacturing project: overview and selected results.* Journal of Operations and Production Management, 1997. **17**(7): p. 671-685.

17. Hanson, P., Voss, C.A., Blackmon, K. and Oak, B, *Made in Europe: A four-nations study*. 1994, IBM: London.

18. Hanson, P.a.V., C.A, *Benchmarking best practice in European manufacturing sites.* Business Process Re-engineering and Management Journal, 1995. **1**(1): p. 60-74.

19. Voss, C.A., *Alternative paradigms for manufacturing strategy.* International Journal of operations & Production Management, 1995. **15**(4): p. 5-16.

20. Greswell, T., Childe, S. and Mull, R., *Three Manufacturing Strategy Archetypes - A Framework for the Aerospace Industry*, in *Strategic Management of the Manufacturing Value Chain*, B.U.a.C. A, Editor. 1998, Kluwer Academic Publisher. p. 53-61.

21. Voss, C.A., Åhlström, P and Blackmon, K, *Benchmarking and operational performance: some empirical results.* Benchmarking for Quality Management & Technology, 1997. **4**(4).

22. Davies, A.J., Kochhar, A.K, *Manufacturing best practice and performance studies: a critique.* International Journal of Operations & Production Management, 2002. **22**(3): p. 289-305.