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The History of Thought in Operations Management: A European Perspective

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1. Introduction

The aim of this paper is to create a European perspective on the history of thought in operations management and to analyze driving and determining factors shaping different schools of thought. An attempt to describe the European contributions to operations management's history of thought will by necessity be heavily influenced by the authors of the description. Even if the description can be based on facts, in the form of publications, individuals, and organizations, there is a need to interpret and reflect on the facts. The view presented here is produced by a researcher holding a professorship in Industrial production and with a background in executive development and consulting, together with his research assistant holding a Ph.D. with special studies of production system change and implementation. Part of the database is, however, distinct and real and has not really been accessed by anyone else. The database consists of twelve years of experience of assessing thousands of abstracts and manuscripts from all over Europe submitted to the European Institute for Advanced Studies in Management (EIASM).

2. A Long Term Historical Perspective

A striking observation when looking into the documented history of operations management is that the history seems to be short. In already existing surveys, the perspective is quite often that the history started around 1980, with the inauguration of the *Journal of Operations Management* in the US and the *International Journal of Operations and Production Management* in the UK (Voss, 1995; Filippini, 1997). Another frequently held view is that the history of operation management started with Taylor. An important event, which is said to start a new era, was the publishing of Skinner's (1969) seminal article *Manufacturing: Missing link in corporate strategy*.

So when did operations management's history start? Historical research certainly demonstrates the value of the researchers' device: "publish or perish" – documentation is key for research to have an impact. Despite the lack of documentation, operations management has an early and even ancient history. The first known production descriptions are probably those of building the Egyptian pyramids about 2700 BC (Keop's pyramid). These production descriptions do not contain much text but pictures describing production system design, layout, work methods, work organization, material flow, etc.

The ancient history of operations management has no doubt been influenced by European culture, including values and ways of thinking. Some major, documented, achievements that should be mentioned are the following: First, the Greek construction activities with projects such as Knossos in the period 1500 – 1200 BC, Olympic projects 400 BC (a great service management case), and the construction of Alexandria 300 BC. A next generation of great

construction management was the large projects of the Romans, 700 BC – 476 AD. An important operations management thought developed by the Romans was that of functionalism, with a strong division of work.

There are few production descriptions between the fall of Rome and the Renaissance. The lack of references may well be due to the values (the dark time) of the middle ages. However, an early form of industrialization was built on the raw material mills, for example in Sweden, with wood and metal mills. Whole communities were built around the large companies that were forming. The oldest still existing company was established in 1288.

The 13th century saw the creation of a new type of organization, the town, starting in Italy. This brought to the world a new type of commercial operation, namely banking. The Renaissance brought a new openness, resulting in increased international trade, which meant radically new approaches to service operations. Worth mentioning here are Italian and other sea-tours, for example those of Vasco da Gama in the 1400s and the Dutch trading and shipping companies that developed during the 17th century.

In the 1600's manufacturing was born. The "manufacture" was a workshop for manual manufacturing before the industrialism. The word "manufacturing" comes from the latin *manus facere*, which means "hand making". The manufacturing concept enabled outsourcing of operations to small farms and cottages from estates and manors already in the 17th century.

At this point in history, we are still suffering from good documentation, since the art of printing was not developed in Europe until the mid 15th century. Printing of longer series was not really possible until the development of rotation and cylinder printing in the 19th century. The first widely spread book, with huge importance to our area, must be *An Inquiry into the Nature and Causes of the Wealth of Nations*, published in 1776, by Adam Smith (Scottish, 1723-1790). Like the Romans and later Frederick Taylor, Adam Smith is related to ideas of division of labor and the functional work organization. What Smith observed was one of the most important steps in societal evolution and a prerequisite for studying manufacturing plant management: The Industrial Revolution, which started in the UK from around the mid-1700s and was clearly existing around 1780.

Even if Adam Smith is often referred to, a more substantial analysis of the manufacturing concept and its application in the industrialization was made by Charles Babbage, most importantly in *On the Economy of Machinery and Manufactures*, which was published in 1835. Babbage contributed very detailed non-technical descriptions of manufacturing processes. He also developed methods for work studies and analyzed many of the concepts we still deal with, such as economy of scale.

The Industrial Revolution meant the workplace concept changed from that of the mill to that of the workshop ("Werkstatt" in German). The development of operations management from here on was around a new form of production management. The new form included real division of work, but also the development of the machine operator, the material handler, and other functional specialties. Entrepreneurial English and Scots spread the Industrial Revolution over Europe in the late 18th century and early 19th century.

Europe dominated the industrial scene in the first half of the 19th century but America took over in the second half. One problem in Europe was the lack of workforce, which initiated the development of ever more efficient machines. One example was the sewing machine, which enabled the outsourcing of sewing to home workers in the second half of the 19th century.

In the latter parts of the 19th century, most of the development and thinking in operations management turned to America and for a long period of time most ideas came from there. The importance of Taylorism and Fordism is well known to all of us. At the same point in time, a long era of administrative orientation in started in Europe, with contributions from for example Fayol (1949) and Weber (1940) which seemed to have no or little influence in the US. Although Weber first published his work in 1921, he was not published in the US until 1947.

The history of thought in operations management has from the second world war been heavily influences by the United States. The 1970s saw the development of a strong quantitative orientation towards production and material control problems. This quantitative orientation also influence European thoughts and practices in operations management. However, there were ideas coming out of Europe, which had a strong influence on the rest of the world. Consider for example the following:

- Work organization and worker conditions have been important in Europe, at least from the Industrialization and maybe even earlier. This focus has been the basis for many important contributions, most importantly sociotechnical systems theory (Trist and Bamforth, 1951), which still influences among other things production system design and work organization.
- Although referring mainly to general management, the concepts of organic and mechanic systems of management (Burns and Stalker, 1961) had implications also for operations.
- The contingency school of thought, which developed in the mid-1960s, was a major new way of thinking in European management. Most clearly focusing operations management was Woodward (1965) who dealt with different aspects of production management and technological contingencies on production organization. Some issues in focus were span of control, separation between line and staff, organizational levels, organizational consciousness, definition of positions, and ratios of direct to indirect personnel.
- The further development of contingency theory was influenced by the Aston studies (Pugh et al., 1968). In a series of influential papers, a group of UK researchers investigated the relationship between an organisations technology and organisation structure .
- On the more technology-based side we recognize a breakthrough in group technology (Burbidge, 1975), which developed simultaneously in the UK and the Soviet Union. Group technology opened a wide range of layouts and other aspects of production system designs between the functional and the product workshop.

Up until this time in history, research on operations management is not easy to define. It is not until the mid-1970s the term “operations management” is coined and we see publications under this classification. So far we have had to search under the classification of economic/company history, technological history, general history, and organization theory. Let us now turn to the documents classified as operations management from 1980.

3. Modern History: From the Birth of Operations Management in 1980

Several observers see the year 1980 as an important landmark in the development of operations management as a strong and distinctive discipline (Voss, 1995; Filippini, 1997). By the 1980s, scholarly journals in operations management had been established, catering both for the US - *Journal of Operations Management* and for Europe, primarily the UK - *International Journal of Operations and Production Management*.

The *International Journal of Operations and Production Management* provides a basis for discerning the development of operations management in Europe. Neely (1993) conducted a review of articles published in the journal between 1980 and 1990. Using the framework developed by Chase (1980), Neely classified published articles into four categories based on two divisions:

- Research approach - micro (narrow and well-defined problems) or macro (larger and usually less well-structured problems).
- Research emphasis - does the research focus predominantly on people or equipment?

Analysis of this categorization indicates that, at the beginning of the 1980s, there was a tendency to conduct or report research on hard topics with a micro orientation. Throughout the 1980s, however, there was a steady trend toward increased macro and soft research. In contrast, the research processes vary substantially on an annual basis, and it appears that the choice of research process has not been subject to the same pressures as research content.

Voss (1995) made a review of *International Journal of Operations and Production Management* between 1990 and 1995 with respect to level and trend of publication rate by topic, see Table 1.

Table 1 Publication Rate by Topic in IJOPM between 1990 and 1995

Trend	*Level* *Low*	*Medium*	*High*
Up	Maintenance Research methodology	Quality Practice performance Cellular manufacturing Flexibility Performance management	Lean production/Just-in-time Manufacturing strategy Implementation
Static		Service Flexible Manufacturing Systems/Advanced Technology Computer Integrated Manufacturing	Models Simulation Production Planning and Inventory Control
Down	Economic Order Quantity Buffer stocks Optimized Production Technology Robotics	Manufacturing Resource Planning	

Table 1 shows a trend of an increasing dominance of issues such as strategy, competitiveness, and general operations management. Diminishing in importance has been production and material planning and control together with production technology. Voss concludes the development exhibited in the table may be strongly influenced in the UK by research funders

such as the Engineering and Physical Science Research Council and industry. These have put much emphasis on the need to have widespread applicability in industry and on conducting research in the field. In fact, researchers who wanted funding were forced to explore real macro rather than micro issues in conjunction with industry (Neely, 1993).

Articles published in journals give one perspective on operations management in Europe. A perhaps equally important perspective is given by operations management conferences held in a European context. Conferences give a view of the field as research in the pipeline. Conferences also give an idea about the breadth of the subject, since the published papers are less subjected to the academic peer review procedure. In this respect, an analysis of conference proceedings is an important complement to the analysis of articles published in scientific journals.

Our analysis of conferences is based on the main conference for European researchers in the field: the annual meeting of the European Operations Management Association (EurOMA). The EurOMA series of conferences started in 1994, when two separate conference organizations joined: European Institute for Advanced Studies in Management (EIASM) and the United Kingdom branch of Operations Management Association. To get a proper historical and European perspective, our analysis includes all the proceedings from the EIASM series of conferences on "Management and New Production Systems" (1987, 1989, 1991, and 1993). Thus, in total the analysis covers eight conference proceedings.

The analysis of the conference proceedings took place from four perspectives: country, university, type and subject. The *country* in which each contributing author's *university* was based was the two first classifications. Each paper was then classified as belonging to one main subject category. Each paper was, finally, classified as belonging to one of the following *types*: theoretical, modeling, field, survey or case:

- *Theoretical papers* cover theoretical material with little or no empirical evidence, literature reviews, discussion of new ideas or reviews and extensions of existing theories and models.
- *Modeling papers* cover new or modified theoretical models, often of a quantitative nature or simulations with theoretical examples or worked examples but generally no empirical evidence.
- *Field papers* cover data from research in the field, data from more than one company or a mixture of research methods.
- *Survey papers* cover quantitative data gathered using survey methodologies, generally questionnaires.
- *Case papers* cover data from one or more companies or data presented in a self-contained way so that the "case(s)" form a separate part of the paper.

Since our analysis focuses on operations management as an academic discipline within Europe, we excluded the following from our analysis:

1) Papers solely authored by non-European academics or by company representatives.
2) Authors from outside Europe appearing as co-authors together with European authors.
3) Authors from companies appearing as co-authors of papers.

The results from our classification are shown in Table 2 to Table 5. Under each table are given, in bullet point format, some observations that can be made from the tables. We will expand upon these observations later on in the paper. We start by looking at the classification of the conference papers by country.

Table 2 Classification of Conference Papers by Country

	1987	1989	1991	1993	1994	1995	1996	1997	Average
United Kingdom	12.8%	6.9%	15.5%	44.7%	65.5%	54.7%	68.4%	38.1%	38.3%
The Netherlands	40.4%	31.0%	24.1%	7.9%	7.6%	13.7%	4.0%	5.8%	16.8%
Sweden	14.9%	17.2%	24.1%	18.4%	2.7%	8.5%	4.0%	3.6%	11.7%
Italy		6.9%	13.8%	14.5%	9.9%	17.1%	8.6%	11.5%	10.3%
Belgium	8.5%	6.9%	10.3%	5.3%	2.7%		1.7%	5.0%	5.1%
France	6.4%	13.8%	8.6%	2.6%	1.3%	1.7%	2.3%	0.7%	4.7%
Spain		6.9%		2.6%	2.7%			16.5%	3.6%
Germany	12.8%	3.4%		1.3%	2.7%		2.3%		2.8%
Ireland					0.9%	1.7%	5.2%	2.9%	1.3%
Hungary	4.3%				0.9%			2.9%	1.0%
Yugoslavia					0.4%			7.2%	1.0%
Denmark			1.7%		1.8%	2.6%			0.8%
Norway		3.4%					0.6%	2.2%	0.8%
Finland			1.7%	2.6%				1.4%	0.7%
Bulgaria		3.4%							0.4%
Portugal					0.4%		0.6%	1.4%	0.3%
Switzerland							2.3%		0.3%
Czech Republic					0.4%				0.1%
Poland		6.8%	3.7%	2.6%	2.6%	2.6%	3.5%	0.7%	0.1%

- On average, the contributing authors are dominated by UK, followed by The Netherlands, Sweden and Italy. Together these four nations make up 75% of all contributing authors.
- For Swedish and Dutch authors the share has gone down, whereas Italian authors exhibit a relatively stable trend.
- The trend for UK authors has been increasing. This is due to the way the conference series were formed. Of late, the conference has also been held in the UK every other year.
- There is a relationship between the location of the conference and participating authors: The Netherlands in 1987 and 1995, France in 1989, Sweden in 1991, UK in 1993, 1994, and 1996, and Spain in 1997.
- The table shows a clear geographical split and a focus on the North Atlantic part of Europe.
- The data shows how the conference has evolved from a small but European-wide conference, to a larger, but narrower conference (in terms of participants from the three schools of thought).

In terms of institutional belonging, the contributing authors came from a variety of different schools. The top ten represented schools are shown in Table 3.

Table 3 Classification of Conference Papers by School

Rank		1987	1989	1991	1993	1994	1995	1996	1997	*Total*
1	Cambridge University, UK	0	0	0	5	18	9	24	3	59
2	Polytechnico di Milan, Italy	0	0	3	2	11	11	8	11	46
3	Chalmers University of Technology, Sweden	4	1	9	12	3	2	1	2	34
4	University of Plymouth, UK	0	0	0	0	22	5	4	2	33
4	Sheffield Business School, UK	0	0	0	4	12	5	5	7	33
6	UMIST, UK	0	0	0	3	13	1	10	3	30
7	University of Twente, The Netherlands	5	3	6	4	2	9	0	0	29
7	University of Padova, Italy	0	1	3	4	7	5	4	5	29
9	Cranfield, UK	0	0	1	3	5	1	11	4	25
10	Eindhoven University, The Netherlands	4	2	3	1	5	4	1	1	21
10	Tilbury University, The Netherlands	0	3	4	0	5	0	3	6	21

The table reflects the importance in Europe of “Universities of Technology”. These are academic organisations specialised in high-level education of future managers, but are not equivalent to business schools. However, it needs to be pointed out that the location of the conference affects the table, in that researchers from the country and school the conference is located it often tend to dominate the conference, due to reasons of travels. In terms of classification by subject, the results are found in Table 4.

- The highest ranked subject is “competitiveness/strategy”, which on average 18.8% of the paper have dealt with. The proportion has been fairly stable over the years.
- The second most popular subject is “operations management general”. It has also remained stable over the years.
- The following subjects exhibit a decrease in interest over the years: Technology, human resources, planning and control, scheduling, and costing and accounting.
- The following subjects exhibit an increase in interest over the years: TQM, supply chain/logistics, and product design/development.
- Service management is on the increase, even if the average is exaggerated, since in 1997 the topic of the conference was service management.
- The interest for Just-in-time seems to have peaked in 1993.

Table 4 Classification of Conference Papers by Subject

	1987	*1989*	*1991*	*1993*	*1994*	*1995*	*1996*	*1997*	*Average*
Competitiveness/ strategy	14.3%	15.8%	15.0%	15.0%	21.1%	22.2%	44.0%	2.8%	18.8%
Operations management general	17.9%	10.5%	10.0%	17.5%	13.8%	9.3%	19.0%	2.8%	12.6%
Technology	25.0%	15.8%	20.0%	7.5%	1.8%	3.7%	1.2%	2.8%	9.7%
Service management	0.0%	0.0%	0.0%	2.5%	3.7%	9.3%	2.4%	57.7%	9.4%
Planning and Control	21.4%	26.3%	5.0%	5.0%	2.8%	5.6%	2.4%	1.4%	8.7%
Human Resources	14.3%	15.8%	17.5%	0.0%	3.7%	1.9%	2.4%	2.8%	7.3%
TQM	3.6%	0.0%	5.0%	10.0%	10.1%	14.8%	3.6%	8.5%	6.9%
Supply chain/logistics	0.0%	0.0%	5.0%	5.0%	8.3%	7.4%	7.1%	7.0%	5.0%
Performance measurement	0.0%	0.0%	0.0%	5.0%	12.8%	7.4%	7.1%	4.2%	4.6%
Costing/Accounting	0.0%	10.5%	2.5%	10.0%	3.7%	3.7%	0.0%	0.0%	3.8%
Product design/ development	0.0%	0.0%	0.0%	5.0%	6.4%	9.3%	4.8%	4.2%	3.7%
JIT	0.0%	0.0%	5.0%	12.5%	1.8%	1.9%	3.6%	0.0%	3.1%
Scheduling	0.0%	5.3%	10.0%	5.0%	3.7%	0.0%	0.0%	0.0%	3.0%
Re-engineering	0.0%	0.0%	0.0%	0.0%	6.4%	1.9%	1.2%	4.2%	1.7%
Process design/ development	3.6%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
Quality control/systems	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	1.2%	1.4%	0.6%
Inventory management	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

The conference papers were, finally, classified according to research method, see Table 5.

Table 5 Classification of Conference Papers by Type of research

	1987	*1989*	*1991*	*1993*	*1994*	*1995*	*1996*	*1997*	*Average*
Theory	46.4%	15.8%	32.5%	30.0%	36.7%	14.8%	33.3%	25.4%	29.4%
Modeling	10.7%	36.8%	7.5%	0.0%	1.8%	3.7%	2.4%	0.0%	7.9%
Field	7.1%	21.1%	32.5%	12.5%	15.6%	16.7%	2.4%	14.1%	15.2%
Survey	17.9%	10.5%	12.5%	15.0%	16.5%	20.4%	27.4%	26.8%	18.4%
Case	17.9%	15.8%	15.0%	42.5%	29.4%	44.4%	34.5%	33.8%	29.2%

The main conclusion that can be drawn from Table 5 is that European researchers favor field based methodologies in front of modeling. Modeling has particularly lost ground in recent years. There is instead a strong dominance of methods in which the researchers are active in the organizations on the field. The combined methods of field and case studies cater for on average almost half of the articles. Since surveys are often used to collect some data in field and case studies, the active field work approach may well be used in over half of the papers. There is also a preponderance of theoretical papers, which reflects the focus in some European countries of developing conceptual frameworks.

4. Three Perspectives of Operations Management in Europe

Having presented the database, we now turn to an analysis of the history of thought in operation management in Europe. The history of thought in operations management in Europe can be analyzed, we propose, from three different perspectives: the cybernetic perspective, the work organization perspective, and the industrial engineering perspective. These three perspectives are a product of the historical development of the subject and create a large divide in the European academic community interested in operations issues. The three different perspectives of operations management are thus not only a way of conceptually differentiating the subject: the perspectives developed in parallel in different ways in Europe. The patterns of development are important to understand in order to fully understand the rather diverse and divided picture of operations management in Europe today.

The divided picture of operations management in Europe is, to at least some sense, dependent on the historical development of the subject. Up until the mid 1940s, operations management within Europe was to a large extent dominated by work organization issues and sociotechnical theory. Analysis started from the point of the character of the work itself and how humans were influenced by and could influence their work. For many reasons Europe had a strong American influence after the Second World War, the Marshall plan being only one example. In management, the logistics perspective was adopted early on. As an effect, operations management in Europe developed a strong quantitative approach, starting in the 1940s. This approach added to the prevalent views and we can recognize three rather different perspectives on operations management.

In the *cybernetic perspective* of operations management, the emphasis was on controlling and optimizing the processes controlling the material flow through the operation. The aim of the operations function was seen as responding to market needs as quickly and efficiently as possible. Loading and scheduling were in focus. In the cybernetic perspective two different disciplines emerged, which we call “production control” and “production economics”.

- The production control interests were around controlling and steering the material flow and scheduling the operations performed by machines and workers. Model development and simulation were important ways of dealing with issues. The issues were not necessarily real issues but different types of problems could be dealt with in general terms. Optimizing the production processes from a throughput point of view was the objective.
- The production economics interests were around economizing resources for the production of the goods. Financial calculations and other models were used to ensure investments were used as efficiently as possible. The production economics discipline received an, if possible, even stronger quantitative orientation than the production control discipline.

The *work organization perspective* has long historical roots in Europe. However, after the Second World War, work organization received less attention. Almost everything that could be produced could also be sold and attention turned to minimizing the negative effects of a basically unhealthy work environment. Both the mental and physical protection of the worker became important and developed into ergonomics. The sociotechnical view was reduced to man-machine studies and there were frequent studies of the design of dials and levers to ease reading and handling them.

In the *industrial engineering perspective*, the focus was on the design and efficient utilization

of the production system. The perspective was strongly influenced by American mass production thinking and focused on how to move in the direction of the efficient driven line. There was also a tradition of focusing a somewhat lower level of analysis, that of the machines and the workers. Productivity was a major objective and the goal was to maximize utilization of machines and workers. Mechanization and automation were important tools for increasing productivity. A characteristic of the perspective was, a strong influence from production technology and engineering. Machine performance enabled continuous improvement, a basic concept in rationalization.

5. Factors Distinguishing between Perspectives on Operations Management

There are several factors that have influenced the development of the different perspectives of operations management in Europe. To some extent these factors are general for the discipline, to some extent the factors are specific to Europe. We focus on the European uniqueness, perhaps with the risk of overstating the distances in some differences.

5.1. Faculty or School

The focus on different issues and the difference in research approach are first of all influenced by the academic setting. Academic organizations and their history are different in Europe compared with the US, which makes the academic setting an important context to understand. Even within Europe the history of academic organizations is different enough to form an important discriminating factor.

One aspect of the academic setting is the existence in Europe of specialized organizations for higher academic teaching and research, for instance the German “Hochschule” and the French “Ecole Superieur”. These schools are often translated as Universities of Technology or Business Schools within a University. However, the organizations are not to be likened with universities. In most cases, the intention has been to educate elite practitioners with research-based knowledge. The organizations often focus management, while universities focus disciplines in the social and behavioral sciences. The degrees are equally difficult to translate. Master of Science is frequently used for something that is called “Diploma Kaufmann” in German or “civilingenjör” in Swedish. The contribution of these specialised organisation to operations management thinking in Europe is, to some extent, captured in Table 2. Of the top ten contributing schools to operations management conferences in Europe, seven are linked with the universities of technology.

Different schools of thought within operations management have also developed in different academic organizations. The European “University of Technology” has often focused the needs of engineers in future managerial positions. Important subjects in the curriculum are for example production system design, layouts, production technology, the control of material flows, statistical quality control, allocation and utilization of plants and equipment, planning techniques, managing the production function, organization of line and staff in production, wage systems, productivity measures, product cost calculations, work organization and worker safety.

Business schools within Europe have, on the other hand, often focused the needs of the general manager. Important subjects in the curriculum are for example investment calculations, product cost calculations, and allocation and utilization of plant and equipment.

There exist many research institutes, which add to the fragmented picture of operations

management in Europe. Applied research institutes are often closely connected to specialty University organizations ("Hochschulen" in German). These institutes attract research funding as well as researchers who split their time between academic research institutions and the institutes. The research products are, in addition to problem solving for industry, new knowledge particularly on applications and implementation procedures, often developed through the deep insight gained through close contact with few cases.

The universities, finally, with their disciplinary division of tasks, have in general not touched upon many managerial issues. One important exception is that of work organization which has been an important perspective in the fields of psychology and sociology. This brings us to dealing with the same database, operations management in Europe, from the vantage point of disciplines.

5.2. Academic Disciplines

The academic discipline forms a second discriminating factor in the history of thought in operations management in Europe. Technology and the industrial society (productive unit) have played important roles in the development of the European society. Historically, there has been a strong belief that technological development can improve life in many ways, typified in the industrialization, which was a British and European development and way of thinking. Hence, a good deal of early European operations management comes out of engineering. Engineers have played and still play important roles in the management of companies in many European countries. The importance of engineers was early recognized and meant there was a need for a high-level education of engineers, which led to the creation of the "Universities of Technology" mentioned above, around 1800.

A starting point for operations management in the engineering discipline is that of organizing and planning for men and machines as well as planning the processes. Group technology is an example of the engineering discipline. Pure production research, with a focus on technology, was expanded over time to include more of managerial issues, even if research started with practical problems like layouts and production planning. The engineering discipline is well reflected in for example the *International Journal of Production Research*, a publication for production engineers, which dates back to 1962.

The discipline of business economics plays, in comparison with engineering, a much smaller role in the European development. One area though has been strong, that of managerial economics. Calculations of costs and incomes as a basis for decision making plays an important role in teaching as well as in practice. However, one can not say it has been an important part of research in operations management, rather a tool on loan from accounting.

The sociological and behavioral sciences have, on the other hand, played important roles in the development of operations management in Europe. The formation of the big industrial workplaces in the industrialization era created a need to deal with work-related issues such as motivation, leadership, division of work, work organization, and span of control. Before the creation of "Universities of Technology" and business schools, these issues were dealt with by university departments in psychology and sociology. With a growing demand for more management-oriented approaches, the efforts made in universities have often been added to by the engineering and business disciplines, with subjects such as work organization and ergonomics.

5.3. National cultures

Europe is multicultural and also multilingual, as are all geographical areas depending on the

level of analysis. Europe's long history with its different countries and ethnographic human tribes encompasses many values with a high degree of variation (as reflected in Hofstede, 1980). Not surprisingly, the European approaches to operations management show a high degree of variation. It is possible to discern and characterize systematic cultural differences, for instance in the areas of interest and research approach.

The clearest discriminating borderlines between national cultures follow the language barriers. This may seem a bit surprising, but is related to publication. The discriminating factor between different schools of thought is based on the research being written in English, French, or German. We call the three schools of thought in operations management associated with the different languages "the North Atlantic", "the Latin", and "the German". The differences between these three schools of thought are considerable and have the profound effect of members almost never meeting. The split in professional associations and conference attendance is almost complete.

The North Atlantic school publishes in English and is the internationally most well known. Its major contributors are found in the UK, the Nordic countries, the Netherlands, and the northern part of Belgium and Italy. The North Atlantic school dominates the conferences which were analyzed earlier. To some extent this reflects the split in conference attendance and research focus. Strategy and general management perspectives are important as well as work organization. The research is often pragmatic and is carried out in close relation with companies. Professors and other researchers are fairly often recruited from industry. Projects are often a combination of research and consulting and hence research issues are often dealing with "how to" and "what when".

The Latin School publishes in French and covers a large geographical area with substantial academic activity, much of which is unknown to members of the North Atlantic school. Many contributions to the Latin School are French, but there are also contributions from Belgium, Switzerland, and South European or Mediterranean countries. Production control is an important focus and studies are often based on modeling and simulation. The distance between industry and academia is sometimes considerable and it is not infrequent to hear a French researcher being very clear in keeping his distance to companies (generalizations are, however, difficult to make and there are those who take the opposite position). However, just as the art of discourse is as important as winning the argument, the art of modeling the production system is as important as, or more important than, managing it.

The German School includes Germany, Austria, and Switzerland. Eastern European countries are also strongly influenced by the German school. Production technology, production system design, production and material control, and automation are important focuses. A rather separate orientation towards work organization with a sociological perspective is also strong in the German School. The German School has no tradition of business schools and much of the research is carried out in "Universities of Technology" ("Technische hochschule" in German). There is a close collaboration between industry and research, for example in research institutes directly related to the "Technische hochschule". In the behavioral science field, companies are more suspicious towards researchers. It seems that to be recognized as a researcher you must be practically and implementation oriented. Such researchers often hold

top industry positions, in some cases even with double doctorates. A German management researcher is a rare participant in a European operations management conference and even with a good attempt it can be difficult to find a German reference in North Atlantic School publications.

6. European Practices in Operations Management

The European history of thought in operations management is influenced by practice as well as by research. However, describing all European practices in operations management is not possible. What we can do is to discuss some practices and their variation across Europe. In the next section, we will describe a case where attempts are made to develop production systems for European cultures.

6.1. Cultural Influences on Operations Management Practices

Operation management practices are often in line with those of general management and more general observations on cultures. The people managing and performing operations are inhabitants of a culture and bring their values to work. The lead author's long experience of observations in company-visits and communication with executives from all over Europe reveals a picture that is close to that of Hofstede's (1980) description of management styles in different cultures. Following our classification of operations management in Europe into three schools, we can observe the following:

- The operations management practices of the North Atlantic School are comparatively focused on work organization and involvement of workers. The organization structure in companies is rather flat and with considerable functional integration. Control systems have low uncertainty avoidance and the amount of delegation is high.
- The practices of the Latin School are comparatively focused on optimizing and controlling the processes. Managers have a high level of conceptual knowledge and the organization hierarchy has many levels that are strictly followed. The control system is hierarchical with high uncertainty avoidance, which means orders are direct and specific.
- The practices of the German School are built around experts; managers that are experts in the process technology and plenty of staff with expertise in different areas. The control system is formal with high uncertainty avoidance, which means that orders are direct and specific.

One could suspect that these observations are based on myths, but actually reveal themselves clearly in pan-European meetings and in how participants in executive training deal with different problems.

Apart from the cultural influences on operations management practices, there are some "harder" influences. One such influence is regulation and legislation, which may lead to different ways of managing. One example is that of rules for depreciation and other financial legislation, where differences lead to differences in decisions of manufacturing to order versus to stock.

6.2. American Literature Influence

Except for the influence from societal cultures, general and operations managers are influenced by what they read and what is discussed. Here we have to consider the almost total dominance of American literature in operations management textbooks as well as in management literature. Twenty years ago managers had read Buffa's textbook, if anything at all. Today, managers have read (or attended a seminar about, alternatively engaged a management consultant who told them about) for instance *The Machine that Changed the World* (Womack et. al., 1990).

However, it is frequent that participants in executive or management training will claim there is one thing in the literature they do not feel comfortable with, description of work organization and industrial relations. Here the distance between European and American practices is considered too big. The American approach to industrial relations is seen as being built on management's and the work forces' different interests, resulting in conflicts or even war. The European reality is instead considered to be one of talks, negotiations, and other forms of endless contacts.

7. Volvo Europe - A Case Study of European Developments in Operations Management

As an illustration of the development of operations management in practice, the case of Volvo is chosen. Volvo has been a forerunner in developing alternative forms of work organization. Less known, however, is the company's development of new concepts for production system design. Furthermore, although Volvo origins in Sweden, it is a global company and from a production point of view, European company. The developments of concern here have taken place in a European perspective.

Our analysis takes place over a period of more than twenty-five years. The aim is to identify patterns of operations management over time in order to give a comprehensive overview and inspiration for future debate and research. The unit of analysis is radically new plants, a concept used within Volvo when developing manufacturing strategies and practices over time. Five radically new plants are analyzed, from the following three perspectives:

- *Operations environment* - driving forces and demands on the production system.
- *Managerial issues* and manufacturing strategies.
- *Basic production philosophies* of the plant.

The data for the analysis have been collected over more than twenty-five years. Some data were collected in plant visits, interviews, and written material twenty-five years ago, some only months ago, representing the lead author's interest and involvement over time. To reduce the risk of bias company representatives have validated the text.

7.1. The Kalmar Plant - Early to Mid-1970s

Our analysis of the developments at Volvo starts in the early 1970s. The *operations environment* in the early 1970s was characterized by economic prosperity. Markets demanded what could be produced and an increasing number of people bought capital goods. However, objections were starting to arise concerning the objective of life and whether the achievement of the new welfare was worth working harder for. The strict forms of leadership in industry, politics, and academia were being questioned, culminating in 1968, with the student

revolution in Paris. This started a long era with the view that industrial work was a necessity, which should be avoided. With the risk of oversimplifying, the *managerial issue* during the early to mid-1970s was to recruit workers. Working at the driven line was seen as something ultimately bad and it was almost impossible for Volvo to recruit workers for their assembly factories.

Volvo's response to the problem of recruitment was the creation of the Kalmar plant. The *basic production philosophy* of the plant was to break up the assembly line and create small factories within the large factory. One way of achieving the goal was the clover-shaped layout. In each clover-blade, teams were created, with tasks integrated in them. Each team was made responsible for one phase of the assembly process. The process was separated with buffers between the clover blades creating to some extent autonomous sub-processes in the total process. The speed of the flow in each sub-process could, between given limits, be controlled by the workers in that area. In each corner of the clover, the workers arrived to the factory as arriving to a small factory. To move the car bodies in the plant, auto carriers were used. The auto carriers are the plant's perhaps most known feature. Auto carriers provided a dock workstation possibility. The bodies also could be tilted on the auto carrier, enabling the workers not having to work "under up", for the first time in car assembly.

7.2. The Uddevalla Plant - Mid-1980s

The *operations environment* in the mid-1980s was characterized by a concern for better working conditions. Costs were rising but so were incomes. America's car production was threatened by the Japanese, but Europe was not threatened yet. European car companies survived through their focus on differentiation and high performance products. However, the quality of the products was a problem, as was the lack of motivation to work.

An important *managerial issue* for Volvo was quality problems. To remedy the problems, the personal dedication among the workers was needed. A way of achieving this was through workers to assume more responsibility for the final product. The aim was to align the individual's goals with those of the company. Prevalent was, finally, still the issue of making industrial work less alienating, even if it was not as strong as in the 1970s.

To address the issues of the mid-1980s, Volvo developed the Uddevalla plant. The *basic production philosophy* of the Uddevalla plant was to let the workers build complete cars, previously unheard of in car assembly. Volvo announced it did no longer want assembly workers, but car builders. The car builders worked in result-oriented teams: a work organization where workers had more or less direct contact with the customer. The organization of the Uddevalla plant was an attempt to create an organization enabling the workers to feel their work created a product for the customer, regardless of where in the organization they worked. This required the workers to build complete cars, with some rather unique effects:

- One effect is "parallelization", that is arranging for the same activities to be performed in several parallel workstations, with increasing tool costs as a result.
- A second effect was feeding the material. The solution was a "material square" in the center of the factory where workers picked a car kit.

The Uddevalla plant was an extremely horizontally integrated organization. However, there was also some vertical integration. Integrated into the teams was responsibility for quality and sales, since workers delivered to the customer. Customers were also invited to see their cars being built, enabling workers to talk directly to the customer. Due to the extensive horizontal

integration work cycles of six to eight hours were created instead of a one-minute balance. The long work cycles were not easy to perform or remember and a new philosophy was developed, based on an idea to fit “functional modules”.

7.3. The Gent Plant - Late 1980s

The *operations environment* in the late 1980s brought tougher competition. American car companies were starting to learn the Japanese way of managing manufacturing and European companies had to go the same way. Best practice was recognized and companies started to implement the practices. An important *managerial issue* for Volvo was to learn more about and implement the practices. Therefore, Volvo took active part in the “Future of the Automobile” study and the “International Motor Vehicle Program”. As a result of their participation in the studies, Volvo created the new Gent plant in Belgium (the first plant outside Japan awarded the Total Productivity Maintenance Award).

The *basic production philosophy* of the Gent plant was to implement lean production practices. An important part of the plant was the VEC-teams (Volvo Europe Car). These are teams characterized by members with no job classifications; multi-trained and multi-task workers. The teams work along a driven line and assume responsibility for all tasks along a part of the line, including responsibility for continuous improvement. Volvo introduced customer-supplier relationships between the VEC teams, instead of having end-customers in the factory and building complete cars.

7.4. The Born Plant - Mid-1990s

The *operations environment* in the mid-1990s was characterized by increasing globalization, resulting in the European operations environment becoming less and less differentiated from the operations environment in other areas. Competitors had to be fought on all markets and a European activity is more and more just a minor part of a global operation.

An important *managerial issue* in this environment was that of being multidomestic rather than multinational. The challenge is one of producing rather advanced industrial products, adapted to culturally diverse customers in comparatively narrow segments. Therefore, Volvo developed a joint production unit, Nedcar, in Born Holland, together with Mitsubishi. In this plant, Volvo contributes product technology and European access. Mitsubishi contributes process technology and production volume, which Volvo needed to get economy of scale in their exclusive products.

The *basic production philosophies* are built on combinations of uniqueness and conformity. The joint venture encompassed a common industrial structure and world class efficiency, but product and brand integrity. The bodies of the different cars must be unique, but follow a common process layout. Similarly, engines are different but engine installation is common. Thus, the product concepts are different but there are common design rules, so-called ”hard points”. The components are also in most cases unique but have common suppliers. The ways the cars are constructed are also unique but the cars have common fasteners. Finally, the two companies’ products have unique under-bodies although being based on a common basic platform. In this manner, it is possible to combine a high-volume standardized operation with uniqueness inside system constraints.

The integration between the different steps in the production process is high in Born, for example between the body-shop and final assembly. An important aspect of the production system design is the body erection concept in the body-shop. The floor is built in the base station and then put into the erection unit, or in reality “the main body jig”. Different sub-lines

are then connected to the erection unit. The left side and the right side are brought into the body-erection unit. The front and the rear-end assemblies are also sub-assembled and brought into the system. Hence, bringing large systems into the final product is an important way of thinking, requiring a system of interface rules. A shorter line with sub-assemblies or sub-activities and sub-subactivites creates more flexibility and fewer disturbances.

Work organization principles in the Born plant come from the Gent plant and follows the VEC-team philosophy, including a continuous improvement program. Material flow in the Born plant is characterized by lean production principles. There is sequential Just-in-Time for many components procured from suppliers and a pull system for the production of the cars.

7.5. The Next Plant - Late 1990s

The *operations environment* in the late 1990s is expected to feature continued globalization. Companies respond with developing and defending increasing variation for even more segments. The era of mass-customization has arrived: the product has to be both best adapted to and cheapest for the particular need. The main *managerial issue* in this environment is to create factories geographically close to the market. This enables producing many models and most of their variants in the same factory without any balance losses. With high multi-type flexible plants, a company can create economy of scale at low volumes. Volvo's development of a plant suitable for producing several models we term "the next plant".

The next plant is a multi-type plant. The *basic production philosophy* for the plant is based on what is called the "Pallet system". There are different pallets handling bodies as well as components and tool-sets. Advanced technology is used to find where the body is and to search for reference points. The reference points can be defined differently from body to body, allowing for a high degree of automation in the body-shop. The whole plant is also characterized by high process-step integration.

Included in the next plant is an idea of creating economy of scope for solutions to product functions together with associate companies and other collaborators. These actors are specialized in developing and building certain functions in the car and will play an even larger role in the multi-type plant. The next plant will have a work organization concept close to the VEC-team approach. Even with especially developed instruction systems it was difficult for workers to have cycle times of eight hours.

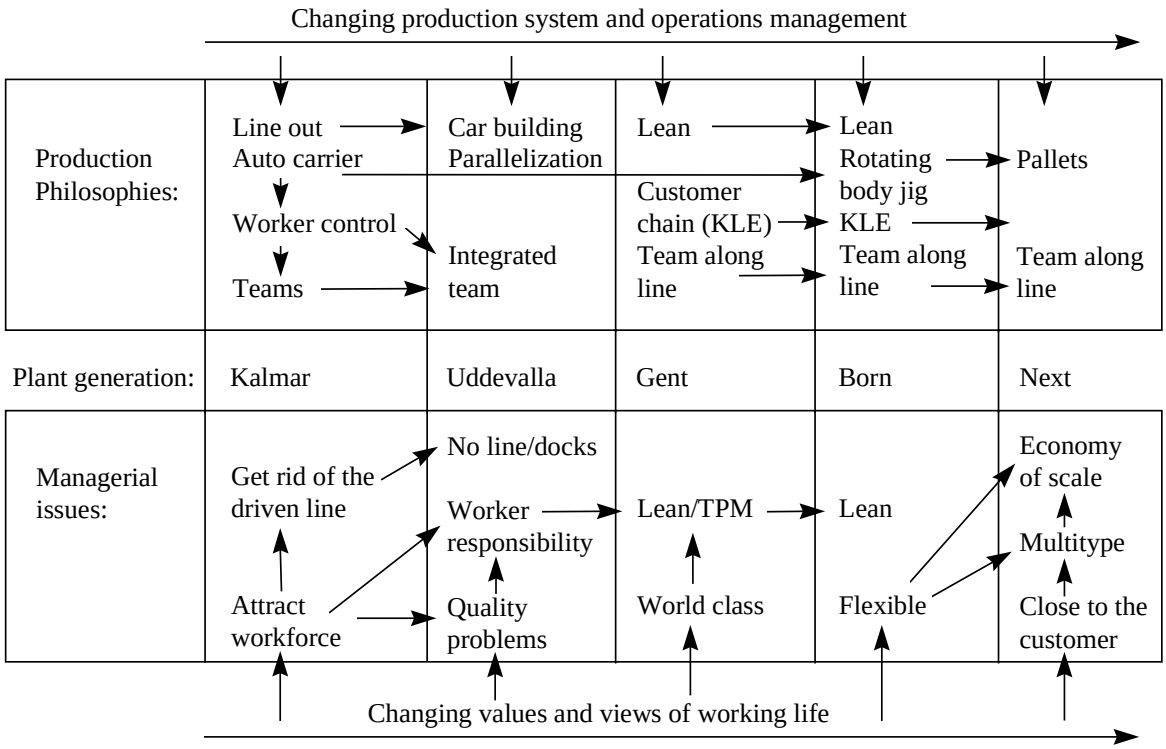
7.6. Synthesis and Summary of the Development at Volvo

The developments in operations management at Volvo in Europe can now be synthesized and summarized. The case may be said to be reasonable typically European. That comes from its combined focus on effective structure for the process flow and concurrent focus on work organization. There is a considerable influence from timely societal issues demonstrating the importance of letting current values influence managerial principles. Over the twenty-five years, managerial issues changed in the way that while early issues were to a large extent those of handling problems (although with visions of work organization), later issues focused much more on strategic competitive advantages for the production system:

- The 1970s saw a focus on work organization with a concurrent interest in effective production and material control. Essential was to break up the driven line but keeping the fast flow.
- In the 1980s work organization issues had long been strong and pushed alternative work organization and layouts. More worker involvement and responsibility was key.

- In the 1990s, progressive globalization forced producing units to develop best practice. To find new competitive advantages in the 1990s, a new kind of multi-type production system was developed.

The Volvo case illustrates the use of the "experimental" plant as an important part of the development of radically new ideas for production concepts. Ideas from the solution in one generation play important parts in later generations. The entry and exit of important ideas are identified in a longitudinal model in figure 1.



The team concept was introduced early and has been a basic idea throughout the development of concern here. The team concept developed gradually, sometimes expanded, sometimes contracted, but has always been there. The team concept demonstrates one of the basic guiding beliefs in Volvo, that of believing in the eternal possibilities of developing the human being. A similar basic belief blocked conceptual development, that of the uncanny driven line. The force of the anti-driven line movement in the company and in society hindered new conceptual thinking, ever so creative, if it involved a line layout. The latest development with pallets carrying base objects as well as tools have some similarities with the early auto carrier idea. It is likely that the conceptual picture of the auto carriers has influenced concept development many years later.

8. Synthesis

The aim of the paper was to create a European perspective on the history of thought on operations management and to analyse and determine factors shaping different schools of thought. A long term historical perspective was taken, starting in the first known production descriptions; those of building the pyramids around the year 2700 BC. The description of the history of operations management in Europe then took us through some important events, such as the large Roman projects, until the time when the first major publications started to appear. A particularly noteworthy event was the advent of the term "manufacturing" (Latin for "hand making") in the 17th century. The manufacture was a workshop for general

manufacturing which enabled outsourcing of operations from estates and manors to small farms and cottages.

The perhaps most important development in the European history management was the Industrial Revolution which started in the UK around 1750. Operations management henceforth developed around real division of work and the creation of functional specialties. The advantages of specialization and a functional division of work, were, however not necessarily new. Already the Romans used specialization in their large projects. The concept was then reinvented by Adam Smith in 1776 and the era of the industrialization led to the concept of specialization being spread widely. It was later to form a cornerstone of the ideas of a very influential observer, Frederick Taylor.

While Europe dominated the industrial scene in the first half of the 19th century, the US were dominant in the second half. Most of the development and thinking in operations management also turned to the US, with ideas on scientific management and the science of mass production. In Europe, a long era of an administrative orientation started. After the second World War, Europe was again heavily influenced by the US and particularly the logistics perspective, which led to the forming of a quantitative view, focusing on planning and controlling the operation. While being influenced by the US, Europe particularly contributed ideas on work organization and management. The sociotechnical systems theory was developed starting in the early 1950s. The contingency school of thought dealt with different aspects of production management and technological contingencies on production organization.

The history of thought in operations management in Europe led to the emergence of three different perspectives: the cybernetic perspective, the work organization perspective and the industrial engineering perspective. These three perspectives are a product of the historical development of the subject and still create a large divide in the European academic community interested in operations issues:

- In the cybernetic perspective of operations management, the emphasis was on controlling and optimizing the processes controlling the material through the operation. The perspective was heavily influence by the quantitative orientation growing out of the US.
- In the work organization perspective, the focus was on protecting and making sure the worker and his work conditions were in unison. Both the mental and physical protection of the worker became important. This perspective has long historical routes in Europe.
- In the industrial engineering perspective, finally, the focus was on the design and efficient utilization of the production system. The perspective was strongly influence by American mass production thinking and focused on how to move in the direction of the efficient driven line.

The history of thought in operation management in Europe and its different perspectives is important to understand in order to fully understand the rather diverse and divided picture of operations management in Europe of today. This divided picture is influence by a number of factors:

- *Faculty and School.* A particular feature in Europe is the relative lack of business schools. Many European countries, for instance, Germany, France, and Sweden, instead have other types of academic organizations specializing in higher academic

teaching and research. In most cases, the intention has been to educate elite practitioners with a research based knowledge. These organizations are not equivalent to universities of technology or business schools within a university.

- *Academic disciplines.* European thinking in operations management has long been influenced heavily by engineering. Engineers have played and still play important roles in the management of companies in many European countries. The importance of engineers was early recognized and meant there was a need for a high level education of engineers. This focus on educating engineers has also been reflected in academic research. In comparison with engineering, the business discipline plays a much smaller role in Europe.
- *National cultures*. European approaches to operations management show a high degree of variation, depending on culture. The clearest discriminating border lines between cultures follow the language barriers due to reasons of publication. Three different schools of thought can be distinguished, based on the research being written in English, French or German. The three schools of thought associated with the different languages were called “the north Atlantic”, “the Latin” and “the German”. The differences between these three schools of though are considerable and have the profound effect of members almost never meeting. The split in professional associations and conference attendance is almost complete, as is members of the different schools of thought reading each others publications.

The split in operations management thought in Europe was to some extent confirmed by our analysis of publications in a European setting. The north Atlantic school dominated what was being published in journals and conference proceedings. At the same item, the analysis revealed the strong contribution of the specialized academic institutions, often translated as “Universities of Technology”. Of the top ten contributing schools to operations management conferences in the Europe, seven are linked with the Universities of Technology.

The divided picture of operations management in Europe is perhaps most of all reflected in the different schools of thought focusing on different research issues, using different types of research methods. With the risk of over simplifying, the following general comments can be made. The German school focuses on production technology, production system design, production and material control and automation. An orientation towards work organization taking a sociological perspective is also strong in the German school. There is a close collaboration between industry and research and much of the research is practically and implementation orientated. Researchers often hold top industry positions. The Latin school focuses production control and studies are often based on modeling and simulation. The distance between industry and academia is sometimes considerable.

The north Atlantic school is the internationally most well known, since it publishes in English. Our analysis of publications revealed that at the beginning of the 1980s there was a tendency to conduct research on hard topics, focusing mainly on equipment, with a micro orientation. This micro orientation meant a focus on narrow and well-defined problems. Throughout the 1980s, however, there was a steady trend towards increased macro and soft research. Macro research dealt with larger, usually less well structured problems, often focusing people. In terms of topics, an analysis of conference proceedings revealed competitiveness and strategy as the main topic, followed by more general operations management, technology, and service management. At the bottom of the list were studies focusing on inventory management, scheduling, and quality control systems. In terms of methods, the north Atlantic schools favors methods which involve direct contact with companies. Field study methods, case methods and

survey methods account for a large proportion of methods used. Modeling and simulation is rarely seen. However, there is a tendency towards developing theoretical frameworks.

Apart from being influenced by research, the history of thought in operations management is also influenced by practice. Although European approaches to operations management in practice is rather naturally diverse, a few patterns can be recognized. These patterns are associated with the division of European research in operations management into three different schools based on language. Apart from cultural influences on operations management practices, there are other influences, for instance from regulation and legislation. However, perhaps most important is the influence of global ideas on operations management, whether these come from the US or Japan.

Regardless of national culture, an underlying theme in operation management practice in Europe is the importance of work organization and the central role in the corporation played by the worker. The role and life of the industrial worker and the effect on society have been major concerns since the late 1700s. Philosophers have also played important roles in European cultures. Individuals such as Weber and Marx have played major roles in forming the view on work, work organization and industrial relations. A European can therefore be said to appreciate an abstract discussion of how a workplace should be organized and managed. The influence of society on how work is organized is also an important factor, which was demonstrated in our analysis of a European case.

Therefore, the involvement of the worker in the organization of work is rather crucial. This involvement may take several forms in different parts of Europe. The involvement may concern negotiation, direct involvement, or power struggles. The involvement of workers involves several areas, remuneration is one aspect; communication, responsibilities and means of control are other aspects of the involvement of the worker. In conclusion, one may argue that in the US people manage production by the numbers, whereas in Europe people manage production by the workers. There seems to be the same difference in how we do research.

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