

## **1. Introduction**

In January 2000, Mercedes-Benz started to implement the Mercedes-Benz Production System (MPS) throughout its world-wide passenger car plants. This event is exemplary of a trend within the automotive industry: the creation and introduction of company-specific standardised production systems. It gradually emerged with the introduction of the Chrysler Operating System (COS) in the mid-1990s and represents a distinct step in the process towards implementing the universal principles of lean thinking as propagated by the MIT-study. For the academic field of industrial sociology and labour policy (Arbeitspolitik), the emergence of this trend seems to mark a new stage in the evolution of the debate about production systems in the automotive industry (Jürgens 2002:2), particularly as it seems to undermine the stand of the critics of the one-best way model (Boyer and Freyssenet 1995).

This introduction of company-level standardised production systems marks the starting point of the present study. At the core of it is a case study about the Mercedes Benz Production System (MPS). The goal of the study is to contribute to the debate about production systems by examining the social and economic implications of the role of standardisation in production systems: at the core of this study are, on the one hand the analysis of the driving forces behind the evolution of company-specific standardised production systems; on the other, from the perspectives of control and power, the analysis of the effects of standardisation on the shop floor. Thus resulting, I will focus on three core questions.

First, what are the driving forces behind the changing forms and functions of standardisation and what role do institutions play in this process ? Second, what impact does standardisation have on the evolution of production systems in the automotive industry ? Third, derived from Adler and Cole's notion of the "learning bureaucracy" (Adler 1993:198, Adler and Cole 1993), how do standards influence the work of actors on the shop floor: do standards contribute to organisational learning processes or do they continue to serve as control tools intended to regulate the work of actors on the shop floor ?

The first two questions will be examined in two parts based on historically-genetic arguments, with the first part focusing on the rise of standardisation driven by the changing forms and functions of standardisation and the role of institutions in this process; the second part explores the role of standardisation in the evolution of production systems in the automotive industry.

The third question about the influence of standardisation on the work of actors on the shop floor in terms of learning and control, will be examined on the basis of my own empirical research and surveys I conducted as part of the company-focused case study of the Mercedes-Benz Production System (MPS).

The introduction of standardised production systems in the automotive industry is part of a far more widespread trend witnessed today: the proliferation of standardisation. The underlying dynamics of this process, according to Power is the need that increasingly "performance must be constructed in such a way that it can be measured, audited and communicated to external agencies in a legitimate, rational form" (Power 1997:114). This process thus seems to signal a change in the driving forces of standardisation: first, in the changing form and function of standards and second, in the role institutions take as standard setters in this process. To examine the former, in my view, it is important to trace the evolution of standardisation from providing standards for the production of interchangeable parts, time and motion standards, recruitment selection standards, skills standards, training and pay standards and quality standards, to process standards today. Of particular importance is the expansion from product quality standards to process quality standards and subsequently, the analysis of the central role standards have for production systems.

Concerning the dynamics driving this evolution of standardisation, one has to consider what role standard setting institutions have played in this process and how it has changed in the course of time. Historically, primarily external institutions have used standards to achieve particular aims: to protect national products from minor quality imports, to raise quality awareness, and to improve the competitiveness of companies, to reinforce centralised structures within companies, and to ensure the harmonisation of processes throughout multi-plant global operations. The introduction of company-level production systems seems to mark a shift from the dominance of external institutions as standard setters, to the dominance of companies as standard setters.

This shift also signals a change in the form and function of standardisation and its impact on production systems. Historically, three distinct models for production systems have emerged: a Fordist-Taylorist model (mass production model), a model based on Volvoism and a Toyotism based model. Obviously, this represents a rather simplified, ideal-type of differentiation. However, these three models (and variations

thereof) continue to dominate and influence the organisation on the shop floor and throughout companies, today. The introduction of standardised production systems though raises the question as to which of the three models has evolved as the major de facto standard model of production systems in the automotive industry. Related to this question of the dominant model of production systems is the effect the implementation of such a standardised production system has on the actors on the shop floor.

Standardisation has been surrounded by controversy and the current debate about standardisation and production system continues to reflect this. Standardisation is primarily associated with Taylorist standards. Based on time and motion studies, standards represent "one best way" of scientific principles of work. Standards are thus seen to primarily serve as regulatory control tools curbing the freedom of actors to individually organise their own work.

In contrast, Adler and Cole argue that the combination between standardisation and the continuous improvement process approach facilitates organisational learning: standards represent temporary best practice solutions which workers on the shop floor can refine. In doing so, their know how and experience is tapped, incorporated into the standard, and thus shared throughout the organisation. Based on two surveys conducted as part of the case study of the Mercedes-Benz Production System, I will examine to what extent Adler and Cole's argument holds true and the effect of implementing a standardised company-specific production system does indeed facilitate organisational learning and the inclusion of the shop floor know how and experience.

## **1.1 Theoretical perspective and literature**

The remaining part of this introduction is divided into three parts and is intended to give an overview of the most relevant theoretical perspectives and literature of this study, the research methodology and approach used, and a chapter overview.

After placing the study in an academic context, in the first part, I shall introduce the major literature on standardisation and discuss the relevance of the theoretical perspectives raised in the labour process debate and the theory of institutionalisation. Rounding off this part is a presentation of the core literature on production systems and the relevance of organisational learning as theoretical perspective. In the second

part I shall outline the research methodology and approach used. Concluding the introduction to the study, I will give a brief chapter outline.

As introduction to the literature and theoretical perspectives of this study, I will first indicate where the study is located from an academic perspective.

This interdisciplinary study is placed primarily within the spectrum of industrial sociology and production management. From the perspective of industrial sociology it follows in the footsteps of the debate about industrial systems and industrial societies rooted in the works of Durkheim (1893) and Weber (1924), and continues the tradition of examining the interaction between social and technical systems as initiated by the Hawthorn Studies and the notion of socio-technical systems related to the studies of the Tavistock Institute. More currently, it reflects the direction of the discussion about the social aspects within production as discussed by Jürgens (1989, 1993, 1997, 2002), Kern and Schumann (1994), Springer (1999).

The study is also placed within the theoretical spectrum of production management, as it focuses on the design and control of systems responsible for the productive use of raw materials, human resources, equipment and facilities in the development of a product (i.e. in this particular case, the production processes within the automotive industry). Viewing production operations and standards as part of a system, the study continues in the tradition of Bowman and Fetter (1957) and Buffa (1961).

### **1.1.1 Standardisation and the labour process debate**

Standardisation has been a contested issue based on the seemingly irreconcilable arguments that on the one hand standards are needed to regulate issues such as emission standards, health and safety standards and food quality standards; on the other though, this regulatory character of standards curbs individuality and flexibility and is often associated with highly bureaucratic structures.

Concerning standards on the shop floor, standardisation has reached its climax during Taylorism and Fordism. Standards regulate the sequence of tasks the worker has to perform, and based on time and motion studies, a one-best way standard dictates the worker how to perform these tasks. As a result, the worker (subject) is separated from the work (object) which he no longer controls. The worker is thus reduced to a "self-serving cog in an industrial machine" (Badham and Jürgens 1998:36). Alienation occurs as standards divorce the object of work (the task) from the actors (subjects) on the shop floor: work is no longer meaningful but individual

creativity is repressed for the sake of industrial productivity. As Worthy put it, by treating actors as "means" and as "categories of status and function rather than as individual," this resulted in the "consequence of destroying the meaning of work itself" (Worthy 1959:70). This type of work organisation is associated with the alienation image (Badham and Jürgens 1998:40) primarily derived from the theories of capitalism, critiques of institutionalised authoritarianism (Badham 1986, Clegg 1990), and primarily the labour process debate, as I shall now outline.

The labour process theory (initiated by the publication of Braverman's *Labour and Monopoly Capital*, 1974) historically traces the notion of control back to the rise of the factory system, when workers were no longer the masters of the processes on the shop floor. Instead, capitalists controlled the means and organisation of production. Standardisation played a key role in this process. First, the standardisation of parts eroded the function of the traditional craftsmen. The reproduction of identical parts no longer necessitated their skills. Thus, the production organisation became controlled by those who owned the means of production instead of those owning the skills and knowledge of production. This shift of control occurred parallel to the expansion of standardisation from product parts to the standardisation of work processes. Through Taylor's *Principles of Scientific Management*, the first publication which formalised the concept of one best way standards of work, time and motion standards, standardisation became institutionalised.

The significance of standardisation, particularly standards concerning the protection of workers health and their acquired rights, had been raised by union representatives before the rise of Taylorism. Of particular relevance, for example, was the fight for standard working hours (the *British Factory Act 1833*)<sup>1</sup>, the fight for standards concerning breaks (driven by the textile industries in Britain and enshrined in the 1874 *British Factory Act* regulating a 30 minute break per day) and standards regulating the minimum age of workers (primarily to protect child labour, see the 1891 *British Factory Act* raising the minimum age at which a child can be set to work from ten to eleven). Many of these issues had been fought out in Britain, particularly in the textile industry, well before the rise of Taylorism. This also applies to standards

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<sup>1</sup> The Factory Act, 1833 was an attempt to establish a normal working day in a single department of industry, textile manufacture. The way in which it proposed to do this was the following: The working day was to start at 5.30 a.m. and cease at 8.30 p.m. A young person (aged thirteen to eighteen) might not be employed beyond any period of twelve hours, less one and a half for meals; and a child (aged nine to thirteen) beyond any period of nine hours. From 8.30 p.m. to 5.30 a.m.; that is during the night; the employment of such persons was altogether prohibited.

concerning the regulation of health at work, such as for example standards regulating heating, lighting and air conditioning standards, the treatment of hazardous substances, physical strain caused by work, including an entire range of ergonomic standards for the prevention of work related illnesses as first formulated in his "Grundriß der Ergonomie, Wissenschaft oder Lehre von der Arbeit" Jastrzebowski, 1847.<sup>2</sup>

Concerning the role of unions in Taylorism, time and motion standards are of particular relevance. On the one hand, these standards ensure that a specific efficiency level is achieved (standard number of units produced), on the other though, they protected workers from the pressures existing on the shop floor, specifically from the threat of "speeding up" (increasing the speed of the mechanically controlled assembly line). Conflicts concerning "speed-up" represent a classical cause for strikes in the labour relations in the USA and became subsequently regulated by collective wage agreements.

In Germany, time and motion studies became regulated in the collective bargaining agreements between employers and unions (as reflected in the Steinkühler-Tarifvertrag of 1982, Jürgens, Malsch, Dohse, 1993) and are thus subject to integration of works council representatives (Mitbestimmung). In order to prepare these union representatives for their role in the decision making process, they underwent the Industrial Engineering training as offered by the REFA and hence learned the methods and work practices of the Industrial Engineers at first hand. The intention to control the standard setting function of the Industrial Engineers (time and motion standards) by both employers and worker representatives, was particularly evident in the industrial nations in the West. Thus the influence of the Industrial Engineer to control and improve speed and standards at work gradually declined. Instead, standardisation, time and motion, and ergonomic standards and became key subject to the conflicts and negotiations between unions and employers.

Therefore, during the 1980s, the entire functional area of Industrial Engineering, as discussed in *Breaking from Taylorism* (Jürgens, Malsch, Dohse, 1993), became subject to management reform. Subsequently, lean production represented a welcome opportunity for deregulation.

The position of the unions' policy on standardisation served to protect workers in their working environment. Standards from this perspective represent preventative

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<sup>2</sup> Ergonomic standards became formally institutionalised much later with the founding of the British "Ergonomics Research Society" in 1949.

measure to ensure a safe working environment. Continuing to fight for the continue use of these standards, unions also assures the protection and defence of the acquired rights of workers. Insofar, this position is in juxtaposition to Adler and Coles view of standardisation, particularly as tool facilitating organisational learning (learning spiral). Thus, role of the unions in a discussion about the forms and functions of standardisation is certainly a key complement, which so far has received little research attention. However, is less concerned with my research interest of examining the influence of standardisation in terms of learning on the shop floor.

Exemplified by the case of the Mercedes-Benz Production system, I will examine this issue by focusing my analysis on the influence standardisation has on workers on the shop floor, particularly in terms of learning and the inclusion of tacit knowledge into standards.

## **1.2 Aspects of standardisation**

### **1.2.1 The trend towards a standardisation of standards**

Despite its controversial nature though, during the course of history, standardisation has gradually penetrated all areas of life, up to a point where they are finally ingrained in our social values and cultures. Today, at the brink of the new millennium, we witness a) a proliferation of standards and b) at the same time a standardisation of standards: be it the number of different standard paper sizes, the A4 size has become the standardised standard; be it the number of European currencies, the Euro has become the standard currency for Europe; be it the number of standards quality management systems developed, the ISO 9000 has become the standard of industry-wide quality management system.

In general, we observe that the number of standards regulating our lives, and social and working processes have increased. This extension of standardisation seemingly confirms a key notion raised in Habermas' early work about the rising dominance of the normative, instrumental world (Habermas 1968). This spread of standardisation "indicates its extreme pervasiveness in modern society" also according to Brunsson and Jacobsson (2000:7).

To take an analogy: it no longer depends on where you are around the world, the spread of the standard ingredients of, say, the Hamburger means that by adhering to

this recipe, it no longer matters if a chef in Peking, Berlin, New York or Rio prepares this dish: its taste, at least in theory, should be the same. In other words, standardisation creates “global uniformity” (Brunsson and Jacobsson 2000:1). By adhering to standards, our international chefs ensure that their dishes taste as well as the original: the adherence of standards is therefore inherently linked to the assumption of ensuring the correct, good quality. But how can constant quality be achieved ?

### **1.2.2 De facto and formal standards**

In order to produce standard quality, a common document listing details of the content and form of standards is needed. The closest to such type of document is provided by the International Standards Organisation (ISO) which proposes the following attributes of standards:

- a) “A written document, accessible to the public.
- b) A document established by a method drawing on consensus in the general interest
- c) A document intended for repetitive and common application
- d) A document approved by a recognised body
- e) A document which relies on the achievements of science, technology and experience
- f) A non-obligatory document by its very nature” (Hesser and Inklaar, 1998:36-37)

The aspect of formalisation in this definition helps to distinguish between informal, unwritten, commonly used de facto standards on the one hand, and formal, written, normative standards. De facto standards evolve informally as more and more actors adopt them. Be it a product, process or even a particular social behaviour, once accepted as a common fact, it becomes a de facto standard. This is for example the case with Microsoft "Word" which has emerged as the standard, de facto word processing programme: only over a period of time and through widespread usage it evolved as a customary de facto standard. The second type, normative standards, are already created with the purpose to norm. Unlike de facto standards which exist,

whether legally recognised or not, normative standards are legally binding, once they are part of contractual obligations.

This distinction between de facto and normative standards is also particularly relevant for production systems as it helps to differentiate between informal, commonly used practices as part of the shop floor knowledge (the tacit dimension), and formalised standards.

Both, de facto and normative standards though have one common denominator: they regulate. The regulating function of standards ensures co-ordination and co-operation (Brunsson and Jacobsson 2000:1). Mintzberg, for example, considers the "standardization of work processes, standardization of work output and standardization of work skills" as part of the five core mechanisms which serve to co-ordinate organisations (Mintzberg 1983:4). Thus, standards can be considered control instruments. An interpretation also confirmed by Brunsson and Jacobsson, who furthermore distinguish between the regulatory nature of standards, norms and directives. Whereas norms are defined as internalised, unreflected rules that we accept as self-evident part of our lives (for example norms of social behaviour and ethics), directives are mandatory, formalised and written rules (for example, the Civic Law).

### **1.2.3 Standard setters and institutionalisation**

Brunsson and Jacobsson suggest that standards, too, provide rules, but unlike norms, are "explicit and they have an evident source" (Brunsson and Jacobsson 2000:13). As economic actors we thus know who issues the standards, whereas the source of social norms of behaviour are difficult to determine as they were not developed by institutions but instead evolved from generation to generation as part of our cultural heritage. The authors also stress the voluntary nature of standards as prerequisite that "standardisation presupposes an ability on the part of the adopter to act independently" (ibid.:6). The success of standards hence depends on the willingness of the economic actors to adapt them. Thus, standardisation can only be achieved if people are willing to accept a standard. The greater the number of standard adopters, the stronger the degree of standardisation.

To differentiate between the different role actors have in the standardisation process, Verman (1973) developed a three dimensional model of standardisation. According to the author, standards cover a three dimensional standardisation space confined by

three axis denoting subject, aspect and level of standardisation, as shown in the diagram below.

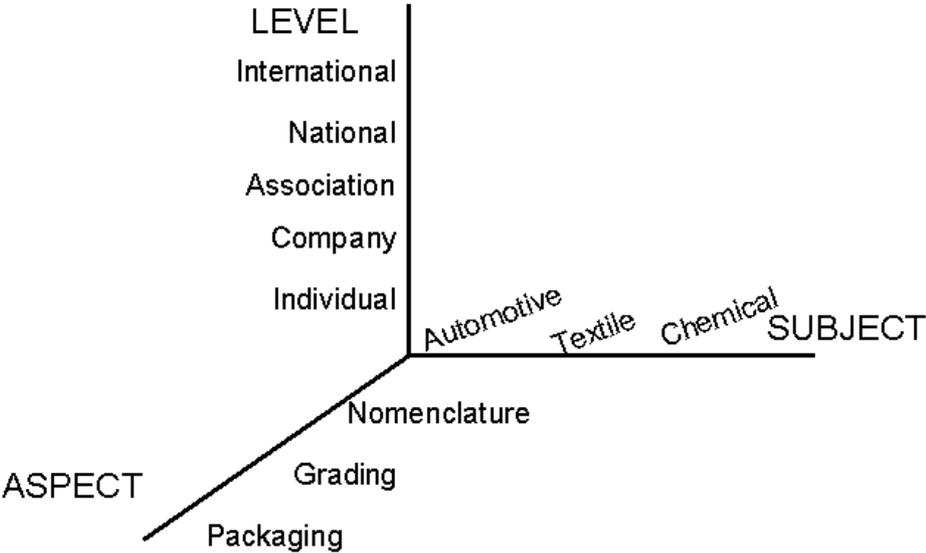


Fig. 1. Diagrammatic presentation of Verman’s model of standardisation space (source Verman 1976:33)

Along the first axis, the subject of standardisation denotes the type of economic activity regulated by standards such as for example industrial sectors like the textile, chemical or automotive industries. The second axis clusters the various types of standards, for example standards of nomenclature, grading, packaging and labelling. The third axis, the level of standardisation defines the “operational level of a standard” (Verman 1973:34), or put simply “the domain to which a standard may be applicable” (ibid.). Verman suggests a 5-tier division of this domain a ranging from standards applicable to actors, company, the association, a national body and finally an international body.

From the perspective of institutionalisation this differentiation also helps to distinguish between the different levels of the agencies of institutionalisation, ranging from the individual actor developing his own standard working sequence as a routine, to international standardisation organisations like the ISO, setting international standards. These institutions represent building blocks which contribute to the permanency and stability of social and political structures. As such, institutionalisation

refers to a process in which "gesellschaftliche Zwänge, Verpflichtungen und Gegebenheiten den Status von Regeln im Handeln und Denken in einer Gesellschaft annehmen, d.h. zu Institutionen werden" (Walgenbach, P., 2000:21). Standardisation serves "die Mittel und Zwecke in einer Form in Übereinstimmung zu bringen, die in effizienter Weise vorhersagbare Ereignisse produziert" (ibid.:18). The predictability of behaviour standards improves economic efficiency, particularly in form of transaction costs which occur as goods and services are transferred as a result of human action. In order to curb transaction costs, organisations develop new governance structures and as Williamson deduces, "the modern corporation is mainly to be understood as the product of a series of organisational innovations that have had the purpose and effect of economising on transaction costs" (Williamson 1985:273). With their intention to improve the economic efficiency of processes within and between companies, standards represent organisational innovation and hence the process of the institutionalisation of standards contributes to the reduction of transaction costs. Companies create and introduce their own standards in addition to standards set by external institutions. This is for example the case with the introduction of production systems.

According to Mintzberg, the standard setters in typical "Machine Bureaucracies" (Mintzberg 1983), such as the automotive industry belongs, are located at the level of the technostructure. In his view, "control analysts of the technostructure serve to effect certain forms of standardisation in organisations" (ibid.:15). Distinguishing between the Industrial Engineers as work-study analysts, planning and control analysts and quality control engineers, Mintzberg's definition of the technostructure reflects that the role of standard setters is located in specific departments removed from the actual operative part of the organisation. This view somewhat points towards the continuation of a Taylorist division of labour whereby the standard setting, is strictly divorced from the direct physical work on the shop floor. The standard user is not integrated into the standard setting process and standardisation is a function and a responsibility institutionalised by a few, professional standard setters in the technostructure of the organisation. The opposite of this role of standard setters are highly decentralised "Professional Bureaucracies" in which standards "originate largely outside its own structure, in the self-governing associations its operators join with their colleagues from other Professional Bureaucracies" (ibid.:192). This division shows that the institutionalisation of standards is driven by a relatively limited number

of highly skilled professionals working either in technostructure of the organisation or at external standard setting institutions. Insofar, organisations are seen to adapt to "their institutional context" (Meyer and Rowan 1991:48). They do so because they "are driven to incorporate practices and procedures defined by prevailing rationalised concepts of organisational work and institutionalised in society" (ibid.:41). However, as pointed out by van Burg, driven by the competitive mechanisms of the market, companies take an active approach toward institutionalisation of standards (van Burg 2001). Moreover, as Meyer and Rowan pointed out, they "actively seek charters from collective authorities and manage to institutionalise their goals and structures in the rules of such authorities" (Meyer, and Rowan 1991:49). This step involves that "their immediate relational networks" adapt the organisation's own structures and procedures. According to Fligstein, companies thus have "differential power to dictate the actions of others in any given field" (Fligstein 1991:314). The author adds that the co-operation within the industry and across competitive boundaries is achieved as "members benefit from the formation of stable rules governing legitimate actions in the field" (ibid.).

#### **1.2.4 Globalisation: driving force for the institutionalisation of standards**

One major driving force underlying the process of standardisation in the economy is that the introduction of standards results in a simplification and economisation of management functions, particularly as companies pursue globalisation strategies and set up international multi-plant organisations. The management of national, country-specific or plant-specific differences is eased as standardisation creates uniform processes and procedures.

In the case of Toyota, the development and adherence of company-specific standards throughout its international production facilities eased the transfer of Toyotas manufacturing principles from its Japanese production facilities to its international plants. Be it the plant layout, the JIT delivery system or the Kanban, standardised operating procedures help to harmonise the manufacturing processes of global operating companies (Hofmann 2000:5). Personnel rotations, changes in production location, and performance comparisons are harmonised, potentially making management more economically efficient.

As standards reduce the variety of practices, they harmonise operations, an effect which also contributes to cost reductions and greater economic efficiency.

Organisational learning and the continuous improvement of processes play a key role within this process. If companies consider standards not as fixed but as temporary best solutions, encouraging staff to constantly refine and improve standards, standardisation contributes to creating a climate of organisational learning. As a result of this constant improvement, the simplification and harmonisation of processes, standardisation creates stable processes within multi-plant companies. The creation of robust processes is a key driving force behind standardisation, as it warrants quality consistency of products. Through standardisation, production processes are stabilised and become more robust, thus ensuring constant output and constant quality. This applies to both processes inside companies, but also at the interface between companies and their suppliers.

Deploying global sourcing strategies, companies increasingly rely on suppliers. The key considerations in this outsourcing process is to enable a smooth co-ordination of interface processes. To do so, companies and suppliers need to share common standards regulating production processes at these points. They also need common control systems, such as audit and certification systems, to check that these standards are adhered to.

### **1.2.5 Standardisation and certification systems**

The introduction of standardised audit and certification systems, limits the risk underlying outsourcing and global sourcing. Standardisation thus acts as a liability assurance system, as companies select suppliers on the basis of their certification which signals that the supplier adheres to generally accepted standards.

Also, companies gain a competitive advantage once their company-specific solutions (be its products or technical specifications) is accepted as industry-wide standard (Brunsson and Jacobsson 2000:9). From the perspective of the economic theory of standardisation, this is explained by the increasing rates of return or Metcalfe's Law, which means that companies benefit by adopting more wide-spread standards, instead of opting to use highly individual standards. Although, van Burg cites the specific example of network externalities, the economic theory of standardisation may be transferred to the case of production systems in the automotive industry. As pointed out above, three major production system models and variations thereof continue to dominate the automotive industry. According to van Burg though, "a single winner is likely to emerge because as a network becomes larger and

exponentially more beneficial, positive feedback mechanisms kick in, with the result that the leading network drives out smaller rivals" (Van Burg 2001:11). Once this winning model has emerged it represents the best-practice standard. Best practice standards are selected during a benchmarking process. According to Strassheim benchmarking is defined by a certain style of politics that legitimizes political decisions in terms of best practices" (Strassheim 2001:1) and for Naschold (1995) and Naschold and Bogumil (2000) benchmarking represents a tool which serves to counter the irrationality of political processes with the rationality of political planning. Applied to the context of production systems, through the seemingly neutral benchmarking process, best practice standards are identified and thus become legitimised as de facto standards. To control if standards are implemented by actors, the institutionalisation process relies on audits as control tools. According to Meyer and Rowan, "evaluation and inspection are public assertions of societal control which violate the assumption that everyone is acting with competence and in good faith" (Meyer and Rowan 1991:59) and, in accordance with the standards set by institutions.

The success of implementing standardised systems is checked by audits. In these audits the extent to how far standards are actually implemented is examined. However, what guarantees that the actors on the shop floor do actually follow these standards every day ? Through the audit system examining and investigating the extent to which standards are being practiced, the work on the shop floor is controlled and regulated. According to Power (1997), the "increasingly prominent role of internal control systems" is linked to the concept of governance (Power 1997:41) which apart from determining the choice between centralised and decentralised structures, "is about regulating the relationship in complex systems" (Rhodes 1994:151). Thus control is pushed further into organisational structures, "inscribing it within systems which can be audited" (Power 1997:42).

Standardisation plays a key role in the evolution of production systems in the automotive industry as I shall outline in the next part.

### **1.3 Production systems**

Concerning a definition of the term "production system", there is no consensus in terms of a "normierte Begrifflichkeit", (Jürgens, 1999) of production systems. According to the Encyclopædia Britannica a production system is "any of the

methods used in industry to create goods and services from various resources” (Britannica online 2002).

A comprehensive definition of production system is given by Bösenberg and Metzen (1992) acknowledging the inherent complexity of a production system by relating the term to intellectual, political and corporate laws, an approach which hence defines the term production system as a:

“...komplexes System, welches das gesamte Unternehmen umfaßt. Es stellt den Menschen in den Mittelpunkt des unternehmerischen Geschehens. Seine Elemente sind fundierte geistige Leitlinien, Arbeitsprinzipien mit neuen Organisationsüberlegungen, integrierte Strategie zur Lösung der zentralen Unternehmensaufgaben, wissenschaftlich-ingenieurmäßige Methoden sowie eine Reihe pragmatischer Arbeitswerkzeuge für Mitarbeiter.”(Bösenberg and Metzen 1992:7)

Boyer and Freyssenet suggest that underlying the development of production systems is a:

“process of making the technical organisation and economic practices and systems of firms internally coherent and externally viable with the goal of reducing uncertainties related to the market and work, and able to reveal general principles applicable to a variety of geographical spaces and able to ensure a certain level of predictability in the firm’s evolution over time, to the point of leading to a series of macroeconomic and societal configurations.” (Boyer and Freyssenet 1995:113)

Skinner (1985) provides a more tangible definition differentiating between the components of production system as the tools or “hardware”, and organisational elements or “infrastructure” (Skinner 1985:95):

“In designing a production system, what is being done essentially is to establish a set of manufacturing policies. Manufacturing policies are the means by which the basic structural elements of the system are made consistent and pulled together. Manufacturing policies can be thought of in two

parts. The first part has to do with bricks and mortar and machinery. This is hardware or "fixed assets" – the number, capacity, and location of plants and the equipment and process technology. The second part has to do with the infrastructure (integration issue, production planning, scheduling and inventory control, work-force management and quality control)." (Skinner 1985:95)

Argued from a social tangent, production systems represent "a set of new practices and new forms of work and process organisation" (Jürgens 1995:298). Whereas the Mercedes-Benz Production System (MPS) is defined as "an integrated model of how processes should be designed and sustained within the Mercedes-Benz manufacturing" (MPS 2000:5), Monden's definition of the company-specific Toyota Production system provides a goal-focused perspective stating that "the principle consideration of the Toyota production system is to reduce costs by completely eliminating waste." (Monden 1983:2). Jürgens, Malsch and Dohse (1989) are more specific and define the Toyota Production System as a "Verkopplung der Systeme der Produktionssteuerung und der Arbeits- und Sozialorganisation. Das aus dem Zusammenhang resultierende System der Arbeitsregulierung bezeichnen wir als 'Toyotismus'". (Jürgens, Malsch, Dohse 1989:44). The authors stress that Toyotism is based on a "Komplementarität zwischen einem gewissen Grad an Selbstregulierung und an Beteiligung des 'geschlossenen Systems' der Sozialintegration und Sozialkontrolle" (ibid.). Insofar, "die soziale Organisation und vor allem die Arbeitsorganisation, korrespondiert mit Anforderungen der Prozesskette" (Jansen and Jürgens, 1999:35). There are two key aspects denoting the function of production systems:

"zum einen stehen Produktionssysteme im Kontext übergreifender Ziele und Handlungserfordernisse, die sich aus Unternehmensstrategie und dem Markt- und Regulierungsumfeld ergeben; zum andere sind Produktionssysteme Ordnungsmuster für die Strukturierung und Organisation von Prozessen, insbesondere auch von sozialen Prozessen" (Jürgens 2002: 2).

The impact of production systems on social processes is also reflected in the industrial sociology debate on the production systems, as I shall outline now.

### **1.3.1 The industrial sociology debate on production systems**

Historically, three distinct production paradigms have emerged: a model based on Taylorism and Fordism, a human-centred reflective model based on Volvoism, a lean production model based on Toyotism. As pointed out above, obviously this differentiation is somewhat simplified, and in practice, a number of variations of these three models exist.

The first model emerged as the introduction of standardised parts signals a shift from the early "American System Of Manufactures" (Hounshell 1984, Nelson 1974, Skinner 1985) to the introduction of scientific principles of work by Taylor (Waring 1995), Rabinbach 1990). Taylorism supported and eased the introduction of Ford's system of mass production and subsequently the first production paradigm based on Taylorist and Fordist principles, evolved. Set by Industrial Engineers, standards are externally generated, are static and occupy a central place in this model. Time and motion studies, short and highly repetitive cycles characterise this model. The shop floor know how is not incorporated into decisions concerning the work content, structure and process optimisations. As pointed out above, this give rise to the alienation image of work and thus a body of literature focusing on the effect of Taylorism and Fordism on social and human aspects of work (Asher and Edsforth 1995, Gartman 1986, Meyer III 1981) and has initiated the industrial sociology debate about the impact of production systems on the actors on the shop floor and social aspects of work during the first half of the twentieth century.

Following in the tradition of the human-relations school and the Hawthorn Studies, social science research focused on examining the social impact of Taylorism and Fordism on the actors on the shop floor. This debate was initiated by Georg Friedmann's book "Où va le Travail humain ?" (1950). In context to labour studies, the London Tavistock Institute developed a so-called socio-technical systems approach at the end of the 1950s (Trist 1956, 1959, later Emery 1969). This concept was established to stress the interrelation between man and machine and to develop systems which would reconcile both, economic efficiency and the social conditions of work. This concept radiated throughout Europe and led to the introduction of human-centred production systems such as envisaged by the programme on the "humanisation of work" (HdA) in the 1970s which was jointly supported by the

German government and unions (Forschungsinstitut der Friedrich Ebert-Stiftung et. al. 1982; Badham and Naschold 1994).

The socio-technical systems approach led to the "Swedish Revolution" (Agurén and Edgren 1983) and subsequently to the development and introduction of the reflective production system at Volvo Uddevalla in the 1990s. It is characterised by deliberately rejecting the use of standards to regulate work. Volvoism gives the individual worker and teams the freedom to organise their work autonomously. Instead of the highly fragmented work based on Taylorist time and motion standards, teams determine the working speed and the work content is based on holistic tasks and long cycles (Ellegård 1995, 1997, Berggren 1992, Rehder 1992, and Medbo et. al. 1999, Jürgens, 1990, 2000, and Cattero, et. al. 1995).

The late 1980s saw the peak of the success of the Japanese automotive industry. Focusing primarily on an analysis of the automotive industry as the "locus classicus of the new model of production" (Jürgens 1999:5), exemplified by the Toyota Production System (TPS), the most widely publicised study was the Michigan Institute of Technology (MIT) study by Womack, Jones and Roos (1990). Previously, Jürgens, Dohse and Malsch (1985, 1989) had analysed Toyotism and Kenney and Florida (1993), along Dohes and his coauthors explore Toyotism as a "more advanced and exploitative version of fordism - a hyper-fordism" (Kenney and Florida 1993:123).

Toyotism continues in the tradition of the Taylorist-Fordist model, but is not a remake thereof because it introduces a range of new key concepts which clearly distinguish Toyotism: standards are internally generated and through the system of continuous improvement evolve dynamically; work content despite continuing to be based on highly repetitive tasks and short working cycles is team oriented. Processes such as just-in-time mechanisms determine, amongst others, the working speed (Fujimoto 1999, Monden 1993, Ohno 1993, and Jürgens and Nomura 1995, Jürgens 1993, 1994, 1995, Cusumano 1985, and Shimizu 1995).

The impact of Volvoism, the debate about the humanisation of work (HdA Programme) and the introduction of highly automated production processes (automisation), in Germany gave rise to the discussion about "new production concepts" (Kern and Schuman 1984). A key focus in this discussion was the technological impact on the work on the shop floor and the tendency of a "reprofessionalisation" of work as proclaimed by Kern and Schumann in their book

"Das Ende der Arbeitsteilung' (The End of the Division of Labour 1984). A second focus was on the introduction of team-based structures on the shop floor, which was initially met with scepticism from management as well as unions (Jürgens 1995:202ff) but as the studies of Gerst et al. (1999) have shown contribute positively towards worker satisfaction, in the meantime.

Among others, research by Durand (1999) has shown that there are considerable differences of the notion of Japanese-based teamwork within and between national contexts. These differences also apply in context to other elements of lean production focused systems, as pointed out in the study of Altman, Endo, Nomura and Yoshida (1998). The analysis of the differences arising from the adoption of production systems (particularly of lean production based systems) is subject of the research conducted by the GERPISA programme (Groupe d'études et de recherche sur l'industrie et les salariés de l'automobile). Its prime focus is on issues of adoption and transfer of production systems and the rise of hybrid forms of production systems. This is reflected in the publications from GERPISA programme such as Boyer, Charron, Jürgens and Tolliday (1998), Boyer and Freyssenet, (1995), Abo (1994, 1999).

A key strand of literature thus evolving has been concerned particularly with the evolution of production systems, standardisation and organisational learning, also a key concern of this study, as I shall point out in the following part.

### **1.3.2 Production Systems, standardisation and the theory of organisational learning**

In the literature on learning and knowledge, organisations are assessed by their ability to effectively disseminate and generate information. The management of information and knowledge have become important factors for measuring productive efficiency (Lippert, Jürgens and Drüke 1996:238). Picot (1990) claims that they represent additional evaluative factors, Stehr (1994) goes even as far as suggesting that they have replaced traditional factors determining productivity.

Learning and the dissemination of knowledge represent key reasons cited to explain the success of Japanese production management techniques and their production systems. Nonaka and Takeuchi (1995) propose that "Japanese companies have

become successful because of their skills and expertise at “organisational knowledge creation” (Nonaka and Takeuchi 1995:preface). According to the authors, this denotes “the capability of a company as a whole to create new knowledge, disseminate it throughout its organisation, and embody it in products, services and systems”(ibid.). They stressed the importance of the transfer of tacit knowledge into “articulable knowledge” (ibid.:33).

This concept of tacit knowledge had previously been developed by Polanyi (1983). At the core of his work *The Tacit Dimension*, lies the assumption that all knowledge stems from experience. In Polanyi’s words “we know more than we can tell” (Polanyi 1983:4). Cognition is seen as interplay between explicit knowledge and implicit, tacit knowledge. However, Polanyi distinguishes between these two dimensions by suggesting that all knowledge derives from tacit knowing. As such it is logically superior to explicit knowledge and thus the anchor of explicit, inferential knowledge. Building upon these concepts, Nonaka deduces that the dynamic potential of Japanese companies and their continued market dominance is founded on their ability to create structures which facilitate this “externalisation” of “tacit knowledge into explicit concepts”(Nonaka and Takeuchi 1995:64). This knowledge then is shared throughout the entire organisation stimulating the generation of further knowledge.

I shall examine to what extent this concept of learning and the inclusion of the shop floor know how challenges the view of standardisation in terms of controlling the work of actors on the shop floor. Focusing on the analysis of the role of standardisation in production systems, I shall juxtapose the arguments of the labour process debate with the arguments put forward in the discussion about learning organisations. Whereas the labour process debate considers the function of standards to control work, the theories of learning propose that standardisation offers an opportunity for workers to contribute their know how and experience, thus tacit knowledge become transferred into organisational standards. These in turn are disseminated and shared throughout the company; a process which then drives organisational learning.

Following Fujimoto, this link between standardisation and learning is one factor which has also contributed that the TPS has become established as the de facto standard of production systems for the automotive industry. Defined by Fujimoto as Toyota’s ability to “change the manufacturing system in a frequent and regular manner to improve functionality” (Fujimoto 1999:18), “routinised manufacturing capability,

routinised learning capability and evolutionary learning capability”(ibid.:17) are key concepts promoted by the TPS.<sup>3</sup>

For the analysis of the link between standardisation and learning, I shall put focus on the role that routinised learning capability plays. According to Fujimoto it refers to “a set of organisational routines that affect the pace of continuous or repetitive performance improvements, as well as recoveries from system disruptions and deterioration” (ibid.). Thus, Fujimoto considers learning as part of an organisational routine. To distinguish between the different standards used to facilitate organisational learning, Fujimoto differentiates between three types of learning routines: routines for problem identification, routines for problem solving and routines for solution retention (ibid.:19). Whereas routines for problem identification consist of “stable practices that reveal and help visualise problems” (ibid.), routines for problem solving refer to the “ability to search, simulate and evaluate alternatives” (ibid.), and routines of solution retention concern the “ability to formalise and institutionalise new solutions in standard operating procedures, thereby providing stability for individuals who internalise solutions” (ibid.).

### **1.3.3 Standardisation between control and learning: Adler and Cole versus Berggren**

The link between organisational routine and learning is also documented in the so-called “clash of images” (Jürgens and Badham 1998:43), a controversial discussion in the social science debate about the effect of standardisation of work on the shop floor, fought out between Adler and Cole (1993) and Berggren (1994). It documents the clash between the human-centred production approach with the lean production approach.

The premise is that historically, standardisation has often been associated with the ‘bad’ image of work: standards representing systematic constraints upon the

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<sup>3</sup> Routinised manufacturing capability, such as for example poka-yoke (foolproof prevention of defects), jidoka (automatic defect detection and machine stop) or andon (real-time feedback of production troubles), consist of “sets of routines that jointly enhance the accuracy of repetitive information transmission on the shop floor, through the production process to the products themselves” (Fujimoto 1999:17).

Routinised evolutionary learning capability is seen as the ability “to cope with a complex historical process of capability building – or multi-path emergence – that is neither totally controllable nor predictable.”(Fujimoto 1999:21) It hence defines organisational learning in terms of how effectively a company manages to learn from its “intended and unintended actions.”(ibid.) Specifically, it concerns a company’s preparedness for continuously challenging its own standards, for “reinterpreting, refining, and institutionalising those routines that have become established for whatever reasons.”(ibid.:23)

creativity and freedom of the individual actor on the shop floor, as raised in the arguments of the labour process debate discussed above.

The controversy arises, as Adler and Cole (Adler 1993, Adler and Cole 1993) based on their research at the New United Motor Manufacturing Inc.(NUMMI) joint venture between Toyota and GM, challenge this view and instead propose that the standardisation of processes is a necessary prerequisite for the organisation of work, particularly for the continuous improvement process. Considering the TPS as "democratic Taylorism" (1992), Adler and Cole regard the NUMMI plant as a "learning bureaucracy" (Adler 1993:198) in which standardisation features as an "essential precondition for learning" (ibid.:104). Learning primarily occurs as procedures are "designed by the workers themselves in a continuous, successful effort to improve productivity, quality, skills" (ibid.:98). For the authors, this marks a break with the traditional role of the Industrial Engineer as standard setter because at NUMMI, the workers themselves are responsible for the standard setting process and "they learn techniques of work analysis, description and improvement (ibid.:102). Thus comparing NUMMI and Volvo Uddevalla, Adler and Cole conclude that the former represents the superior model. The argument being that the latter in which standardisation of processes has been replaced by a human centred approach where workers organise their work individually, fails to initiate learning processes which go beyond the working teams or the work shop.

From the perspective of the alienation critique of work, Berggren rejects these arguments and proposes a solution based on integrating Japanese production management and product design with American corporate strategies and European approaches in job design such as empowerment and reskilling (Berggren 1994:44).

As pointed out above, this study intends to examine to what extent Adler and Cole's claims apply in the case of the implementation of the Mercedes-Benz Production System (MPS).

## **1.4 Research methods and approach**

In the following I shall outline the research approach and methods used in the study. The first part focuses on the initial research steps commencing with the literature and documentary review, the second part focuses on the case-study approach used.

### **1.4.1 Literature and documentary review**

This research is based on a three year longitudinal study starting in October 1999. I conducted both documentary and empirical research. Concerning the former, I conducted research at the following libraries: the library of the University of Hohenheim, the library of Stuttgart, the library of the Free University of Berlin, the library of the Wissenschaftszentrum für Sozialforschung in Berlin, the library and archive of the DIN in Berlin, the Staatsbibliothek Berlin and the Staatsbibliothek Stuttgart, the library of Fachhochschule für Technik, Esslingen and the DaimlerChrysler library and Archive at the plant Untertürkheim.

Moreover, I drew on company-internal publications and documents of DaimlerChrysler. I thus reviewed all references available, including textbooks, academic papers, professional magazines and newspapers as well as DaimlerChrysler Television broadcasts, internal presentations, speeches given by board members and documents such as minutes and files tracing the evolution of the Mercedes-Benz production system. Emphasis was placed on the most recent material and the sources were critically reviewed. The review also showed what research methods and approaches had traditionally been used in this field (Creswell 1994). It also indicated that an examination of the forms and functions of standardisation in production systems analysed from an industrial sociology perspective represents a new academic contribution in the field (Leedy 1989).

As a result of the literature review, I developed the three research questions, the study addresses and developed a research approach which consists of a combination between a historically-genetic approach and an empirical approach, drawing on both quantitative and qualitative research methods.

Thus, the second chapter focusing on the evolution of the forms and functions of standardisation and the role of standard setters therein, has been written primarily with reference to secondary literature, including classic textbooks and academic articles but also publication by standard setting institutions (ISO, DIN and VDA, for example). In addition, information generated in more than twenty-six semi-structured conducted at standard setting institutions such as the DIN, has been incorporated.<sup>4</sup>

Similarly, the third chapter on the rise of production systems and the role of standardisation is based on a review of secondary literature incorporating textbooks, journal publications and around forty-one semi-structured and unstructured interviews with managers of automotive manufactures other than DaimlerChrysler and also of

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<sup>4</sup> The goal was to conduct a minimum of twenty semi-structured interviews.

suppliers has been taken into account.<sup>5</sup> I conducted these interviews at conferences and during a number of plant visits and on the telephone (interview guidelines see appendix). I thus collected information from BMW (plant Munich), Porsche, Opel (Eisenach), VW (Gläserne Manufaktur Dresden); also from interviews with experts at the Deutsche Institut der Normierung (DIN) in Berlin, the chairman and representatives of the REFA Fachausschuss Fahrzeugbau (REFA section: automotive production) and with experts at Bertrandt, Bosch and Eberspächer. The fourth and fifth chapters focus on the case study of the Mercedes-Benz Production System (MPS).

#### **1.4.2 The case study approach**

The case study is for the social scientist what laboratory experiments are for the natural scientist (Kasanen and Suomi 1987, Smith 1990). Yin (1989) defines a case study from a research perspective as “an empirical enquiry that investigates a contemporary phenomenon with its real life context, when the boundaries between phenomenon and the context are not clearly evident, and in which multiple sources of evidence are used” (Yin 1989:1, 1993).

I chose this method for two reasons. First, my research objective focuses on one specific incident: the implementation of the Mercedes Benz Production System (MPS). According to Bell (1993), the case study approach is particularly suitable for such research objectives concerned with an enquiry around one or a few specific instances or events. Second, I chose the case study approach because the central questions of this present study are concerned with establishing why and how the Mercedes-Benz Production System (MPS) was created and what effect it has once it is being implemented on the shop floor. Yin argues that case studies are particularly “valuable in answering who, why and how questions” (ibid.). This view is also supported by Schramm (1971) who envisages the function of the case study to illuminate decisions particularly why they are taken, how they are implemented and with what result.

However, one also has to point out the draw back of the case-study approach insofar as it introduces a certain bias, a tendency to draw on incomplete evidence (Yin 1989), and is said to lack rigour and objectivity (McCutcheon and Meredith 1993). Moreover, nothing can be deduced from a single case study (Yin 1989). To counter

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<sup>5</sup> The goal was to conduct a minimum of thirty such interviews

these shortcomings, I thus integrated a range of empirically focused methodologies such as semi-structured interviews and two surveys into the case study. The result is a longitudinal panel study which draws on a broad content of statistical, sociological and psychological measures.

I followed Dalton's classic single case study approach with the intention of getting a detailed picture of how a standard production system is being created and implemented at one particular production centre at the DaimlerChrysler plant Untertürkheim. The single case study approach is thus used to "interpret this world and its problems from the inside" (Dalton 1959:1). It's strength is "to highlight a construct by showing its operation in an ongoing social context. The result becomes a much more coherent, credible, and memorable story" (Dyer and Wilkins 1991:616). This case study is based on empirical evidence generated during a longitudinal study of almost three years (October 1999 to June 2002) which I conducted at the DaimlerChrysler AG, plant Untertürkheim.<sup>6</sup> In the role of observer as participant, I accompanied the institutionalisation process of the MPS, from the stages of actually writing it, until its introduction to top management, cascade training, to its actual implementation on the shop floor and its evaluation by the MPS audits.

The research parameters of this single case study is derived from the particular organisational structure and products produced at the Untertürkheim plant. The main product of the plant Untertürkheim is the power train unit used primarily in all Mercedes-Benz passenger cars. The three main components produced in the plant are the axle, the transmission and the engine, and variations thereof such as the V8 and V12 or diesel engines. These products are manufactured in so-called production centres. The case study focuses on examining the implementation of the MPS at the plant Untertürkheim and in particular, at one of the three production centres (denoted throughout the text as production centre Z).

### **1.4.3 Observational and survey research**

For this purpose, I deployed two basic approaches: observational research (Silverman 1994) and survey research (Remenyi, Williams, Money and Swartz 1998). For the observational research, the primary research tools I deployed to generate this information were the following:

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<sup>6</sup> I was able to accumulate the information for the present study thanks to being deployed as a full-time doctoral researcher for the DaimlerChrysler AG during the entire research period.

- More than twenty-four semi-structured interviews<sup>7</sup> (interview guidelines see appendix) conducted internally at DaimlerChrysler.
- Around fifty-two unstructured interviews (usually based on spontaneous interview opportunities arising at conferences or meetings at DaimlerChrysler).
- Approximately thirty-three passive observations (meetings, trainings, conferences) with role of researcher either type 3, observer as participant, or a hybrid role of the researcher as full member of the organisation (type 1) but with recognised status as an internal researcher (type 2 'going native').
- A three week long field study in summer 2001, collecting evidence concerning the effects of implementing the MPS as a fully employed student worker on the shop floor, without organisational members being aware of my research status and company affiliation.

For the survey research I designed a questionnaire and administered two surveys. This method allowed for the collection of a large quantity of data (Oppenheim 1966). With the thus collected numerical evidence and the application of the technique of statistical inference, the research objective was to record and examine changes in the actors' perception towards a range of issues during the implementation phase of the MPS. The topics covered for example, the actors' satisfaction with the level of communication, leadership, teamwork, quality, and their own work; but also their direct perception of the MPS and the extent to which they are involved in the standard setting process. I administered the first survey in November 2000, shortly after the start of the implementation of the MPS and the second survey exactly 12 months later in November 2001. The participants were drawn from a previous randomly selected identically structured population (n) at production centre Z and its three main production departments (sub-centres, A, B, and C).

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<sup>7</sup> The goal was set to conduct at least 20 structured and 50 unstructured interviews and 30 passive observations.

## **1.5 Chapter outline**

The study is structured in a straightforward way. In the next two chapters, my goal is to analyse the driving forces behind standardisation. To do so, in the second chapter I shall focus my investigation on the evolution of standardisation. For this purpose I focus on Germany, the USA, and Japan. The key aspects is the driving force behind the spread of standardisation and the role actors play within this process. For this purpose I divided the chapter into three parts.

In the first part I shall commence with an analysis of the driving forces underlying early institutionalisation of standards in Germany, particularly the role of the craftsmen and guilds in the establishment of early product standards during the pre-industrial era. My focus then shifts across the Atlantic to analyse what drove the development of standardised and interchangeable parts in early 19<sup>th</sup> century North America. By the end of the 1930s, quality standards were institutionalised.

Whereas in America and Germany, the history of quality management evolved from quality control to quality assurance, and was primarily the responsibility of separate quality management departments, the historical evolution of standardised quality management systems in Japan took another turn.

This resulted in the creation of their unique quality management approach, known today as the Total Quality Management (TQM) System, a system which envisages a holistic view of quality and hence represents by far no longer a quality management system but already a production system. This leads then into the second part of this chapter, presenting a detailed analysis of standard "quality management" system used across international industrial sectors.

National and governmental interests do play a role in this process, as standards are considered a means of educating the national industries thus ensuring their international competitiveness. During Fordism, the responsibility for the competitiveness of companies in terms of quality rested with internal centralised organisational units such as the Industrial Engineering and quality assurance departments. However, in the wake of the globalisation of production and sourcing structures, this responsibility has shifted from companies to external international institutions, such as the ISO.

In the third part, I will raise the question of the underlying reasons why companies adopt standardised "quality management" systems. A key part of this analysis is the role, audit systems have in this process. Intended to check if companies adhere to

the standards, audits serve as control tools. The concluding part of this first chapter then examines the significance of certification systems and specifically quality audit processes on the evolution of standardisation and the forms of institutionalisation.

The third chapter covers the major production systems in the automotive industry and is divided into six parts.

I shall start off this historical analysis by looking at the role standards played at the transition from the craft production system to the system of mass production in America. Juxtaposing the role of the skilled craftsman with the factory worker, I will point out how significantly standardisation is for the shift from highly individualised skilled work to highly fragmented and repetitive work.

In the second part of this chapter the focus is on the role of standardisation in Taylorism. Acknowledging, that Taylor's *Principles of Scientific Management* do not represent a production system as such, I think it is nevertheless important to include it in the discussion particularly as it lay the foundation of the first production system of the automotive industry: Ford's system of mass production. Thus I shall analyse how Taylor's division of labour was introduced as a form of standard to organise work and how it functioned to split work between mental and physical tasks, resulting in highly fragmented tasks which Industrial Engineers, through time and motion studies, had previously scientifically engineered.

In the third part of this chapter I will examine how Ford applied the principles of Taylorism in his system of mass production. Regarding the role of standardisation in Fordism, I differentiate between technical and process standards, work standards and social standards. Much is known about Ford as the inventor of the moving assembly line in the automotive industry. However, Ford not only set this new de facto process standard, but also continued to refine systems of standardised jigs and gauges. Moreover he also introduced new products which became standard components of cars such as transmissions. Despite the significance of these technical, process and work standards, I will stress the extension of standards from the shop floor to the social realm of the workers as a key development of the function and role of standards within production systems. The example of the standard pay (the 5\$ Day) for standard work and the standardised selection criteria of workers eligible to receive this wage show just how far standardisation had penetrated the social realm during Fordism. Together with Taylor's division of labour and the job fragmentation, this extension of standardisation into the private sphere of the workers

contributed to the alienation of the worker from his work. As pointed out above, this lay the foundation of the image of alienation of work.

The chapter continues by showing how Fordist principles were disseminated in Japan. Toyota first adopted mass production principles but then continued to develop and refine them until they created their own company-specific production system, the Toyota Production System.

I will focus on the forms and function of standards in the TPS. Two key aspects of standardisation within the TPS are selected: standardised operations and the kanban system. Underlying the standardisation process at Toyota, is the system of continuous improvement of standards, organisational learning takes place as workers learn from each other and exchange their shop floor know how. The analysis of the TPS will be closed by examining the transfer of the TPS outside its national Japanese environment.

In the fifth part, the role and function of standards in the Volvo production system at Uddevalla will be analysed. Unlike the highly standardised TPS, the production system of Volvo Uddevalla explicitly does not intend to standardise processes, operations or methods. As its name "reflective production system" already points out, its intention is to create a human centred production system in which workers have the freedom to organise and perform their own work according to their individual skill level and their own methods of work. In a sense then, Volvo declares the reflective production system to represent their standard way of organising production, although its actual intention explicitly rejects the notion of standardising processes, methods and operations.

In the final part of this chapter the analysis of the role of standardisation in production systems focuses on the current trend to introduce company-level standardised production systems and the question to what extent the Toyota Production System has evolved as the de facto standard model for automotive manufacturers.

The third chapter focuses on the case study of the Mercedes-Benz Production System. For the purpose of examining the institutionalisation of a production system and the particular form and function of the standards therein, and also on the link between the effect of standardisation on the actors on the shop floor in terms of learning and control, this case study is based on an analysis of the implementation of the MPS at the DaimlerChrysler plant Untertürkheim and at one of its production centres.

This chapter covers three main aspects: the evolution of the MPS and its institutionalisation, its structure, content and relation to other already existing standardised systems. The first part presents the production organisation of Daimler Benz and Chrysler before their merger in 1998.

In the second part, an analysis of the institutionalisation of the MPS is given by looking first at the organisational structures supporting the implementation of the MPS. In a second step the role the MPS audit plays within the implementation process will be examined. In view of the regulatory nature of audits, based on my own observations, both the role of the auditor and the auditees on the shop floor are analysed and a set of audit-strategies auditees adopted is presented.

In the third part of this chapter I shall focus in depth on the content of the MPS. First an overview of the MPS and its structure is given. In a second step, the MPS is compared with already established methods proposed by the REFA. The question also arises, as to what extent the MPS is modelled upon the TPS. To investigate this question, a comparison between the TPS and the MPS is drawn.

Apart from analysing the driving force underlying the standardisation process, the second goal of this study is to examine what effect standardisation has on the work of the actors on the shop floor: how far standardised production systems contribute to the image of alienation ? As pointed already out in the methodological discussion above, this question was operationalised into an empirical survey and the results are presented in this fourth chapter.

The purpose of this survey was to collect the opinion of actors on the shop floor during the implementation process of the MPS to thus examine changes in their perception towards the level of communication, leadership, teamwork, quality, and their own work; but also their direct perception of the MPS and the extent to which they are involved in the standard setting process. Within one year, I conducted two identical surveys from a previously randomly selected identically structured population (n) at one production centre (centre Z) and its three departments (A, B, and C). The findings reflecting the changes in opinion of the actors on the shop floor between the two measuring points are at the core of this chapter. The findings are divided into overall centre Z results and individual sub-centre results. In addition, the chapter contains a presentation of the relevant statistical methods deployed and a presentation of the questionnaire design.

In the final chapter, the major conclusions which can be drawn from the preceding discussion and implications for the research question posed, will be presented. What are the implications behind the current process of the standardisation of production systems ? Focusing on the forms and functions of standardisation in production systems, the role of institutions therein and the effect of standardisation on the shop floor in terms of learning and control, the conclusions of this study are presented. I will also point out future research implications and questions arising from this present study and the conclusions it draws.