

Forms and functions of standardisation in production
systems of the automotive industry: the case of
Mercedes-Benz

Constanze Anja Clarke

Submitted for the Degree of
"Doktor der Politikwissenschaften" (Dr.rer.pol)
at the Freie Universität Berlin

November 2002

Erstgutachter: Prof. Dr. Ulrich Jürgens
Zweitgutachter: Prof. Dr. Werner Väth

Disputation: 17.01.03

Erstgutacher:

Prof. Dr. Ulrich Jürgens
Freie Universität Berlin
Fachbereich Politik- und Sozialwissenschaften und
Direktor der Abteilung "Regulierung von Arbeit" im
Forschungsbereich Technik, Arbeit und Umwelt am
Wissenschaftszentrum Berlin für Sozialforschung

Zweitgutachter:

Prof. Dr. Werner Väth
Freie Universität Berlin
Fachbereich Politik- und Sozialwissenschaften und
Leiter der Arbeitsstelle Politik und Arbeit am
Otto-Suhr Institut für Politikwissenschaft

Abstract (for German summary refer to Appendix 1)

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 and 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. In this context it addresses three core questions:

1. What are the driving forces behind the changing forms and functions of standardisation and what role do institutions play in this process ?
2. Second, what impact does standardisation have on the evolution of production systems in the automotive industry ?,
3. Derived from Adler and Cole's notion of the "learning bureaucracy", 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, the third question will be analysed on the basis of my own empirical research and surveys conducted as part of the company-focused case study of the Mercedes-Benz Production System (MPS).

The second chapter thus focuses on the rise of standardisation, particularly in context to the development of quality standards in Germany, American and Japan, and analyses the role of institutions in this process. Its findings state that; companies and customers have driven the standardisation process and specifically war, and that the protection of national industries, globalisation and quality, are the main driving forces of standardisation.

The third chapter explores the role of standardisation in the evolution of production systems in the automotive industry covering the transition from craft production to mass production and Taylorism, and the three major production systems which evolved in the twentieth century: Ford's system of mass production, the Toyota Production System and the reflective production system of Volvo Uddevalla. It shows that standardisation has played a major role in the evolution of production systems in the automotive industry and that the Toyota Production System has emerged as the dominant model upon which currently introduced standard production systems are modelled.

The case study about the Mercedes-Benz Production System is presented in two parts. In chapter four, an analysis of the process of formalising the MPS, its implementation and support organisation, the role of audits, and a comparison with existing methods of work and also the Toyota Production System is given; in chapter five, the empirical findings of two surveys conducted during the implementation period of the MPS are presented. The notion that standardisation contributes to more control over the work of actors on the shop floor (alienation image of work) is not confirmed by the findings. In contrast, the findings show that know how and experience of actors on the shop floor is integrated into standards and thus standardisation facilitates organisational learning.

Declaration

I declare that this thesis has been composed by myself and that the research reported has been conducted by myself unless otherwise indicated.

Oberstenfeld, 10th November, 2002

Constanze Clarke

Acknowledgement

First of all, my thanks to the people without whom this thesis would not have been possible. I am deeply indebted to Professor Dr. Ulrich Jürgens, my supervisor at the Centre for Social Science Research Berlin, for all his help, support and encouragement and Professor Dr. Werner Väth, my co-supervisor. My special thanks to Josef Zwickl, DaimlerChrysler centre manager transmissions, for the interest, encouragement and support he showed for my study, and for allowing me to conduct extensive research at his centre.

I would also like to extend my thanks to all members of staff, at Hedelfingen, Untertürkheim and at the DaimlerChrysler Headquarters, either directly or indirectly involved in the MPS-project, for helping and providing valuable information for this present study.

I am also very grateful to Frank Gäth, Schaefer Marktforschung, Hamburg, for his valuable advice on statistics and his support with the SPSS programming and calculations.

I would like to thank the following people from REFA for their valuable advice: Reiner Lehr, chairman of the Fachausschuss Fahrzeugbau and Wilhelm Appold, Ausbildungsleiter REFA-Fachausschuss Fahrzeugbau. I am also indebted to all the managers and staff of the automotive manufacturers BMW, Opel, Porsche, VW, and suppliers such as Bertrandt, Bosch and Eberspächer who gave their time for interviews.

Thanks also to Dr. Terrence Wynne and Professor Dr. Sven Ulrich at the University of Applied Sciences, Esslingen, and Mr. Klaus Konersmann, Chartered Accountant and Auditor at KonersmannProkasky, for keeping me motivated and for spending their time discussing various aspects of this study with me.

Most importantly, I would like to thank my parents and my partner, Thomas, for their continued encouragement, motivation and tremendous support they have given. Without their love, patience and understanding for me and my work, this thesis would not have been possible.

Last, but not least, I would like to extend my gratitude to workers on the shop floor at the transmission production centre at the DaimlerChrysler plant Untertürkheim. Be it as student worker working for three weeks in the nightshift, dayshift and lateshift on the shop floor, or during meetings, interviews I conducted, I was always warmly welcomed and my research was received with great interest. I would like to thank them for participating in the two MPS surveys I conducted and the valuable comments and feedback they thus gave.

Glossary of terms, symbols and abbreviations

-X-

3K	Kitanai (dirty), Kitsui (stressful) and kiken (dangerous)
A4	DIN Norm for standard paper size
AAM	Alliance of Automobile Manufacturers
AG	Aktiengesellschaft
AGV	Automatic Guided Vehicle
AIAG	Automotive Industry Action Group
ANS	American National Standard
ANSI	American National Standards Institute
AQL	Acceptable Quality Level
ASQC	American Society for Quality Control
AT&T	American Telephone and Telegraph Co.
BBB	Better Business Bureaus
BMW	Bayerische Motoren Werke
BNS 5750	British National Standard
BSI	British Standards Institute
CAMI	Joint venture between Suzuki and GM
CCS	Civil Communications Sections
CD	Compact Disk
CEN	Comité Européen de Normalisation
CEN/TC	Comité Européen de Normalisation / Technical Committee
CEO	Chief Executive Officer
CIP	Continuous improvement process
CNC	Computer numerically controlled
COS	Chrysler Operating System
DC	DaimlerChrysler
DCPS	Daimler Chrysler Production System
DIN	Deutsches Institut der Normierung
DIN EN ISO 9000	Deutsches Institut der Normierung European Norm International Standard Organisation
DM	Deutsche Mark
E5	Ebene 5
EDP	Electronic data processing
EFQM	European Federation of Quality Management
EPS	(Opel) Eisenach Production System
EU	European Union
FAKRA	Fachnormenausschuss Kraftfahrzeugindustrie
FMEA	Failure Mode Effects Analysis
GBR	Gesamtbetriebsrat
GHQ	General Head Quarter
GM	General manager
IEC	International Electrotechnical Commission
IFAN	Internationale Föderation der Ausschüsse Normenpraxis
IFT	International Automotive Task Force
ISA	International Federation of the National Standardizing Association
ISO	International Standards Organisation
ISO/TC	International Standards Organisation / Technical Committee
ISO/TS	International Standards Organisation / Technical Standard
JIS	Japanese Industrial Standard
JIT	Just in time
JMA	Japan Management Association
JSA	Japan Standards Association
JUSE	Japanese Scientists and Engineers
KVP	Kontinuierlicher Verbesserungs Prozess
MD	Median
MDS	Mercedes-Benz Development System
MIT	Michigan Institute of Technology
MPS	Mercedes-Benz Production System

MTM	Methods Time Measurement
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organisation
NC	Numerically controlled
NSBs	National standards body
NSCC	United Nations Standards Coordinating Committee
NUMMI	New United Motor Manufacturing Inc.
PDCA	Plan, Do, Check, Act
PMI	Post merger integration
PSA	Peugeot Citroen S.A.
PWS	Production Work Shop
Q101	Quality standards 101
QM	Quality management
QMC	Quality management centre
QS	Quality standard
R&D	Research and development
RADAR	Result, planning and developing of approaches, deploying approaches, assessment and review of approaches
REFA	Reichsausschuss für Arbeitszeitermittlung Today REFA - Verband für Arbeitsstudien und Betriebsorganisation
REZEI	Reorganisation der Zeitarbeit
ROQ	Return on quality
RPS	Rastatt Produktionssystem
SDCA	Standardise, Do, Check and Act
SPC	Statistical process control
SPSS	Statistical Package for the Social Sciences
SQC	Statistical Quality Control
SWI's	Standard work instructions
TPS	Toyota Production System
TÜV	Technischer Überwachungs Dienst
TVR	British Sports Car Manufacturer
UAW	United Auto Worker Union
UK	United Kingdom
US	United States
US MIL-Q 9858	United States Military Quality Standard 9858
USA	United States of America
USD	United States Dollar
VDA	Verein Deutscher Automobilhersteller
VDA-QMC	Verein Deutscher Automobilhersteller Quality Management Centre
VPK	'Verkehrstechnische Prüfungskommission'
VW	Volkswagen

Fig. 1:	Diagrammatic presentation of Verman's model of standardisation space (Source Verman 1976:33).....	10
Fig. 2:	Overview: evolution of quality management based on models by Hesser and Inklaar, and Junghans.(Hesser and Inklaar 1992: Appendix Fig. 7.1, Masing 1999:5).....	48
Fig. 3:	Masing model of product and process quality (Masing 1999:9).....	50
Fig. 4:	Overview of the evolution of quality standards for the automotive industry from 1987–2002.....	61
Fig. 5:	The integration of the 1994 edition of the ISO 9000 series into the latest ISO 9000:2000 edition.....	67
Fig. 6:	Overview VDA 6.X audit series. (Source: VDA 6.1, 1998:7)	70
Fig. 7:	Einstufung bei Kunden-/Lieferanten (Second party audit). (Source: VDA 6.1 2000:23)	71
Fig. 8:	"How costs, quantity, quality and humanity are improved by the Toyota production system" (source: Monden 1983:4).....	129
Fig. 9:	Elements of standard operations (source: Monden 1983:146).....	131
Fig. 10:	Standardisation and the continuous improvement process in the Toyota Production System.....	137
Fig. 11:	Overview: introduction of company-level production systems. Adopted from Winnes (ed.), 2002: <i>Die Einführung industrieller Produktionssysteme</i> ; Wilhelm, B., 2002: <i>Neue Arbeits- und Prozessorganisation bei Volkswagen</i>	163
Fig. 12:	The organisational structure and corresponding management levels of the Mercedes-Benz plant Untertürkheim.....	168
Fig. 13:	The reference model for the DaimlerChrysler Operating System.....	178
Fig. 14:	DaimlerChrysler Production Systems Overview.....	179
Fig. 15:	Organisational levels of MPS organisation.....	183
Fig. 16:	The MPS implementation organisation at centre level.....	186
Fig. 17:	The MPS cascade training.....	188
Fig. 18:	MPS audit evaluation table 1.....	199
Fig. 19 :	MPS audit evaluation table 2.....	200
Fig. 20:	MPS audit evaluation table 3.....	200
Fig. 21:	MPS audit evaluation table 4.....	200
Fig. 22:	MPS audit evaluation table 5.....	200
Fig. 23:	Overview MPS-structure: Sub-systems and Operating Principles.....	206
Fig. 24:	The MPS Operating Principles and the 92 Tools.....	209
Fig. 25:	Overview REFA-publications.....	214
Fig. 26:	Longitudinal research period of present study and empirical measure points.....	224
Fig. 27:	Sample composition according to hierarchical groups.....	226
Fig. 28:	6-level questionnaire interval scale.....	236
Fig. 29:	MPS survey results: Bar chart Question V.A. Suggested improvements of work.....	239
Fig. 30:	MPS survey results: ranking suggested improvements of work.....	240
Fig. 31:	MPS survey results: Motivating factors ranking.....	241
Fig. 32:	MPS survey results: ranking motivating factors.....	241
Fig. 33:	MPS survey results: MPS expected results.....	243
Fig. 34:	MPS survey results: ranking MPS expected results.....	243
Fig. 35:	MPS survey results: MPS influence.....	244
Fig. 36:	MPS survey results: ranking MPS influence.....	245
Fig. 37:	MPS survey results: Total scores items in the section "Information and Communication".....	246
Fig. 38	The changing forms and functions of standardisation in context to production systems in the automotive industry.....	268

Content	Page
List of abbreviations.....	X
List of tables	XI
1. Introduction	
1.1 Theoretical perspective and literature	3
1.1.1 Standardisation and the labour process debate	4
1.2 Aspects of standardisation	7
1.2.1 The trend towards a standardisation of standards.....	7
1.2.2 De facto and formal standards.....	8
1.2.3 Standard setters and institutionalisation	9
1.2.4 Globalisation: driving force for the institutionalisation of standards	12
1.2.5 Standardisation and certification systems	13
1.3 Production systems	15
1.3.1 The industrial sociology debate on production systems.....	17
1.3.2 Production Systems, standardisation and the theory of organisational learning.....	19
1.3.3 Standardisation between control and learning: Adler and Cole versus Berggren...	22
1.4 Research methods and approach.....	23
1.4.1 Literature and documentary review.....	23
1.4.2 The case study approach.....	24
1.4.3 Observational and survey research.....	26
1.5 Chapter outline.....	27
2. From standardised product to standardised quality systems – the evolution of standardisation	
2.1 Introduction.....	32
2.2 Germany: the historical roots of quality standards.....	34
2.3 The USA: interchangeable parts and mass production.....	38
2.4 The rise of quality management in Japan.....	44
2.5 Quality management in Germany.....	48
2.6 The historical rise of standard setting institutions.....	52
2.6.1 National standards setting bodies (NSBs)	52
2.6.1.1 Deutsches Institut der Normierung (DIN)	53
2.6.1.2 The American National Standards Institute (ANSI)	57
2.6.2 International standards – the International Standards Organization (ISO)	59
2.7 The institutionalisation of international standards for quality systems – the case of the ISO 9001 series, the VDA 6.X, the QS 9000 and the EFQM model.....	61

2.7.1 Historical evolution of the ISO 9000.....	62
2.7.2 ISO 9000 – a standardised quality management system.....	65
2.7.3 The evolution of the ISO Technical standard (TS) 16949.....	68
2.7.4 VDA 6.X series.....	69
2.7.5 QS 9000.....	72
2.7.6 The key differences between the ISO 9000, VDA 6.1 and QS 9000.....	73
2.7.7 Towards a holistic view of quality – from ISO 9000 to the Total Quality Management System (TQM) of the European Foundation of Quality Management (EFQM).....	74
2.7.8 Audits.....	79
2.7.9 The cost and benefits of certification.....	82
2.8 Critical appreciation.....	84

3. The history of production systems in the automotive industry

3.1 Introduction.....	91
3.2 The end of craft production: from the American system to the system of mass production.....	92
3.3 Taylorism and standardisation.....	95
3.3.1 Historical background.....	95
3.3.2 Form and function of standardisation in Taylorism.....	96
3.4 Ford’s mass production: the foundation of modern production systems.....	100
3.4.1 Standards in mass production.....	101
3.4.2 Standardisation beyond the shop floor.....	109
3.5 The Toyota Production System (TPS)	114
3.5.1 Historical background.....	114
3.5.2 The evolution of the TPS in the 1980s and 1990s.....	121
3.5.3 The forms and function of standardisation in the TPS.....	128
3.5.3.1 Standard operations.....	130
3.5.3.2 The kanban system.....	134
3.5.3.3 Continuous improvement (kaizen) and learning.....	136
3.6 The reflective production system of Volvo Uddevalla.....	143
3.6.1 Creating the reflective production system at Uddevalla.....	144
3.6.2 The role and function of standardisation in the reflective production system.....	146
3.7 The current trend of introducing standardised production systems in the automotive industry.....	153

4. Company-specific standardisation: the case of the Mercedes Benz Production

System

4.1 Introduction.....	163
4.2 Case study focus, approach and structure.....	165
4.3 Case study background.....	166
4.4 The production organisation at Mercedes-Benz before the merger.....	168
4.5 The production organisation at Chrysler before the merger	172
4.6 The DaimlerChrysler Operating Model.....	172
4.7 The Mercedes-Benz Production System.....	174
4.7.1 The MPS organisation: central - plant and centre level structures	180
4.7.2 The MPS central organisation.....	182
4.7.3 The MPS plant level organisation.....	183
4.7.4 The MPS centre level organisation.....	184
4.8 Implementing the MPS: the cascade training.....	185
4.9 The MPS-Audit.....	187
4.9.1 Auditors and the audit procedure.....	192
4.9.2 MPS-audit observations.....	196
4.9.3 The effectiveness of audits: theory versus practice.....	197
4.10 The structure and content of the MPS.....	204
4.10.1 The MPS tools.....	206
4.11 A comparison between the MPS and REFA-methods.....	212
4.12 A comparison between the Mercedes-Benz Production System (MPS) and the Toyota Production System (TPS)	217

5. The MPS on the shop floor: the effect of implementing a production system on the actors in production

5.1 Introduction.....	223
5.2 Research scope and methodology.....	224
5.3 Statistics.....	228
5.4 The MPS questionnaire design and content.....	230
5.5 Significances.....	233
5.5.1 The general trend of results at Production Centre Z.....	234
5.5.1.1 MPS improves integration of shop floor know-how and experience into standards and decisions.....	234
5.5.1.2 The MPS improves the co-operation in and between teams.....	238
5.5.1.3 Changes in ratings regarding necessary improvements.....	239
5.5.1.4 Changes in motivating factors.....	240
5.5.1.5 Assessment of the MPS goals.....	242
5.5.1.6 Expected influence of MPS.....	244
5.5.2 Sub-centre results.....	246

5.5.2.1 Sub-centre A.....	249
5.5.2.2 Sub-centre B.....	250
5.5.2.3 Sub-centre C.....	252
5.6 Analysis and interpretation.....	253
6. Conclusion	
6.1 Research questions revisited.....	260
6.2 The driving forces of standardisation.....	261
6.3 The evolution of production systems in the automotive industry.....	264
6.4 The changing forms and functions of standardisation in the evolution of production systems.....	268
6.5 Between learning and control: the effect of standardisation on the actors on the shop floor.....	271
6.6 Outlook.....	275
Bibliography	277
Appendix	295