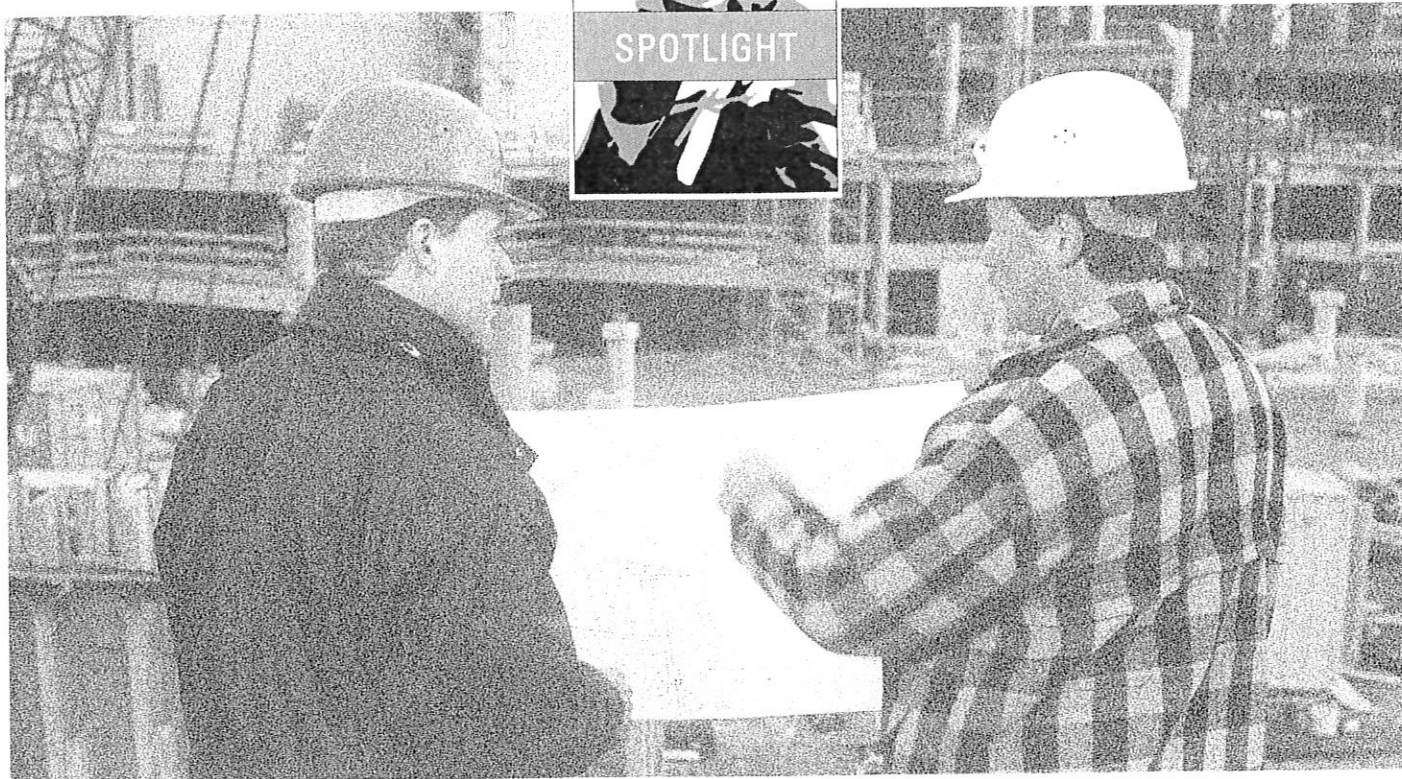




SPOTLIGHT



## STANDARDIZATION AS A SUBJECT OF STUDY IN HIGHER EDUCATION

### A VISION

By Prof. Dr. Wilfred Hesser<sup>1)</sup> and Dr. Axel Czaya<sup>2)</sup>

*For the authors, Univ.-Prof. Dr.-Ing. Wilfried Hesser, Chair of Standardization and Technical Drawing at the University of the Federal Armed Forces Hamburg (Germany) and Dipl.-Volksw. Axel Czaya, a PhD student at the same University in the Department of Standardization and Technical Drawing, standardization as a subject of study can be viewed from a number of different aspects. The multi-faceted*

*nature of the topic and the interlacing of individual aspects from various different specializations have to be combined in order to ensure that teaching and research have a sound basis and are directed towards the*

*current state of science and technology. Standards represent a vast and interesting object of research in the engineering sciences, economics, the science of business management and jurisprudence. In the article below, they assert that an interdisciplinary approach is essential, and claim that the relevance of technical standards extends even beyond these subjects into the realms of humanities and the social sciences.*

## The tradition of teaching

Viewed within a historical context, teaching in the subject of standardization has been essentially characterized by national industrial development in the first stage and the internationalization of markets in the second.

The change in industrial standardization and standardization work can be clearly illustrated by manuals on company standardization dating from the years 1916, 1930, 1955 and 1975.

In the early days of industrialization, the efforts of national and company standardization were directed towards the interchangeability of parts and the development of safety standards in electrical engineering, whereas rationalizing in the field of production became the focus of standardization as industrialization progressed.

Up until the 1970s standardization was primarily used as:

- an instrument of rationalization;
- a method of systematically designing products; and
- an instrument for organizing production, including materials management and control.

In the 1980s, with the implementation of CAD (Computer-Aided Design) systems and CIM (Computer Integrated Manufacturing) concepts, industrial information technology/processing assumed a key function in industry, and with it the exchange of product-specific data beyond the departmental and divisional boundaries. The brief survey below shows a variety of approaches, methods and technologies for defining standards.

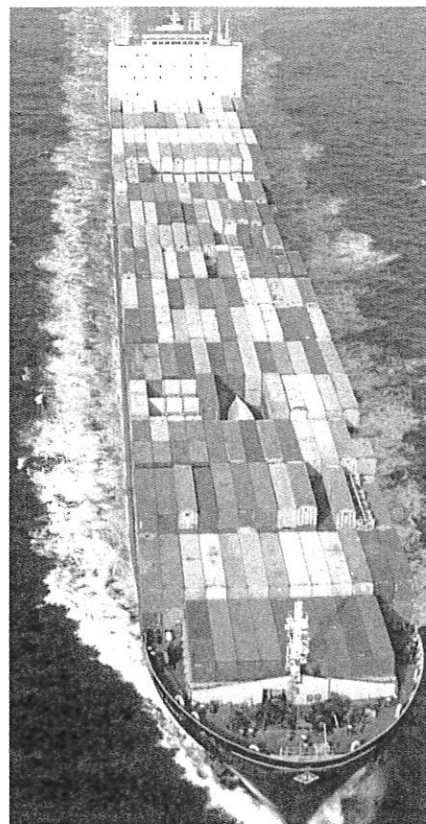
The STEP Standard for the Exchange of Product Model Data (ISO 10303) is used particularly in production where Computer Integrated Manufacturing (CIM) is involved.

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“...The prevailing theories of business management are not suitable for recognizing and exploiting or avoiding the opportunities and risks that arise from the standardization process and the standards themselves”

SGML – Standard Generalized Markup Language (ISO 8879) represents a standardized meta-language for structuring documents within enterprises. EDIFACT - Electronic Data Interchange for Administration, Commerce and Transport is employed to achieve greater efficiency in the structuring and



*Electronic Data Interchange for Administration, Commerce and Transport is employed to achieve greater efficiency in the structuring and processing of both technical and organizational information.*

processing of both technical and organizational information.

These few examples, which could be continued, provide some indication of the relevance that standards and standardization have today in the technical processing of information within industry.

The dawn of the communications and information age has seen standardization emerge from its function as a mere instrument of rationalization within companies. It now provides a strategic dimension for enterprises, which is based upon the economic relevance of standards for occupying markets.

## The state of the science

In the economic sciences, an interest in standards has only existed since the middle of the 1980s. A wealth of contributions on the most diverse aspects of standards and standardization has led to a better understanding of their effects. Many of these contributions focused their attention on standardizing the compatibility between product, systems or services. The academic debate today concentrates mainly on standards and their implications for competitive policy, international trade and company strategies.

The modern science of business management, with its leaning towards the production sphere, is largely process-oriented. The competitiveness of an enterprise is determined by individual processes. If an enterprise standardizes its production process, it may disclose its core competence, and thereby throw away its competitive advantage. In this context, company standardization is seen as negative because standardized processes within enterprises can be reproduced by competitors.<sup>3)</sup>

In management literature, the classical methods of company standardization (e.g., variety reduction) are examined – if at all – *indirectly* as part of a historical account of “scientific management” (particularly of Taylorism).

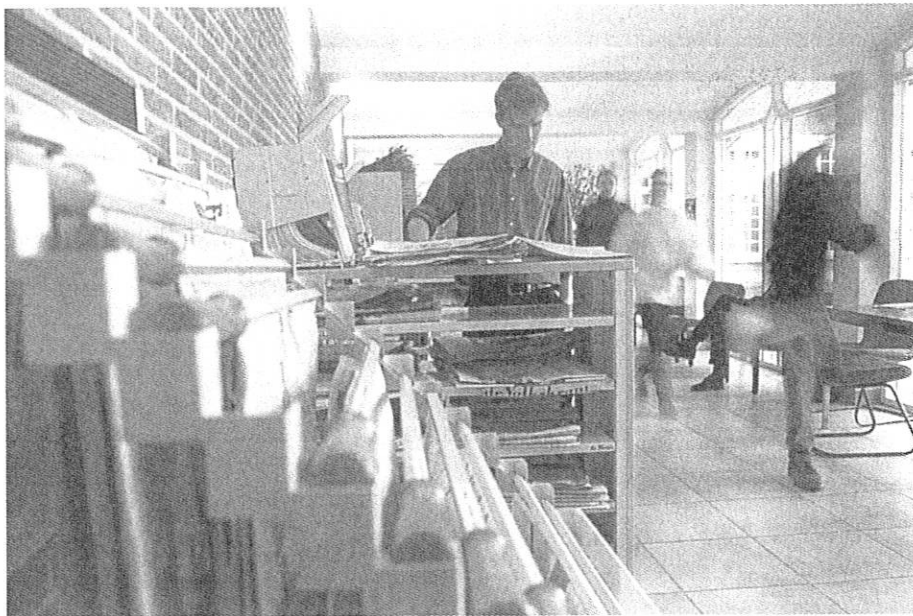
In the authors’ opinion, the rating of (company) standardization that is to be found in current business management literature indicates that there is no fundamental and modern evaluation the importance of technical standardization as an instrument of strategic company management.

3) The view presented here is not shared by the authors, and there are a number of factors that militate against it.

The literature in the engineering sciences on standardization is technically oriented and takes no account whatsoever of the issues relevant to company strategies. Topics discussed include the relationship between standardization within the company and that within standards-setting organizations (such as DIN, AFNOR, BSI, ISO, etc.).

It can be further seen that the prevailing theories of business management are not suitable for recognizing and exploiting or avoiding the opportunities and risks that arise from the standardization process and the standards themselves. This is particularly

and the organizations (e.g. consortia) involved in their development, definition and distribution. The guardians of free trade find themselves increasingly confronted with companies that are trying to eliminate their rivals with patented or copyrighted compatibility standards. In particular, fierce criticism has been levelled at the software manufacturer Microsoft because of its attempts to adopt a dominant if not monopolistic market position with the aid of its operating system that serves as an interface standard between hardware and the user software.



*Explicit reference may also be made to standards within laws. Issues of product liability where non-compliance to standards can be demonstrated are of particular relevance for companies.*

These statements show that standardization as a subject of study can be viewed from a number of different aspects. The multi-faceted nature of the topic and the interlacing of individual aspects from various different specializations have to be combined in order to ensure that teaching and research have a sound basis and are directed towards the current state of science and technology.

### The state of teaching

Let us briefly consider the teaching concepts with which we are familiar:

- Seminar for Technical Standardization (from 1941 to 1955), Lehrstuhl für Betriebswirtschaft und Werkzeugmaschinen der Technischen Universität [Department of Business Management and

Machine Tools at the University of Technology], Berlin/Hannover, Germany

*Prof. Dr.-Ing. Otto Kienzle*

- Standaardisatie en Normalisatie (from 1994 until the present), Faculteit der Bedrijfskunde (Rotterdam School of Management) at the Erasmus Universiteit Rotterdam, Netherlands

*Prof. dr. ir. C.A.J. Simons*

- Technical Standardization - Methods, Effects (from 1985 until the present), visiting professor at the Faculty of Mechanical Engineering at the University of Technology in Clausthal, Germany

*Prof. Dr.-Ing. Helmut Reihlen*

- Standardization (from 1984 until the present), Department of Standardization and Technical Drawing in the Faculty of Engineering at the University of the Federal Armed Forces Hamburg, Germany<sup>4)</sup>

*Prof. Dr.-Ing. Wilfried Hesser*

**“The guardians of free trade find themselves increasingly confronted with companies that are trying to eliminate their rivals with patented or copyrighted compatibility standards.”**

A closer examination shows that the lectures of these teachers differ both in their structure and content. With the exception of Kienzle's lecture course, the content of which may be described as traditionally engineering-based, the lecture courses of Drs. Simons, Reihlen and Hesser deal with the topic of standardization in the context of a modern

<sup>4)</sup> The University of the Federal Armed Forces Hamburg is an institution subject to the framework law governing higher education establishments in the Federal Republic of Germany. Its organization and legal status comply with this law. It is financed by the Federal Ministry of Defence and has the function of educating officer candidates to university degree level.

true of the German-speaking world, where in the most important journals such as *Der Betriebswirt*, *Zeitschrift für Betriebswirtschaftliche Forschung*, *Zeitschrift für Betriebswirtschaft*, the significance of compatibility standards for enterprises and therefore management is simply overlooked. However, standardization as an instrument of strategic corporate management will increasingly attract the attention of company executives within a European system of laws and standards.

In jurisprudence, too, standards have become a topic of teaching and research. A large number of laws refer to the “state of the art” or “the generally acknowledged rules of technology”. Furthermore, explicit reference may also be made to standards within laws. Issues of product liability where non-compliance to standards can be demonstrated are of particular relevance for companies.

There is a need to clarify the issues of competition law in connection with standards

industrialized society. Yet at the same time they set significantly different priorities, which are probably mainly a result of the lecturers' different professional careers.

It can therefore be seen that the first teaching syllabus for engineers and industrial engineers at the University of the Federal Armed Forces Hamburg from 1984 reflected the professional career up to that time of the person responsible for the teaching and research in the subject of standardization. Standardization is taught here as an optional subject in the 7th and 8th trimesters. Teaching takes place in the form of lectures and guided practical sessions. The teaching concept is divided into two main sections:

**Section I:** Importance and applications of standardization in industry and commerce (with three lecture units and one practice session per week in the 7<sup>th</sup> trimester) and

**Section II:** General principles of national, European and international standardization (with two lecture units and one practice session per week in the 8<sup>th</sup> trimester).

The underlying aim of the teaching concept is to provide an interdisciplinary interpretation. During their studies, students of engineering and industrial engineering should gain an understanding of the relations between the various parts of the production and economic processes that are affected by technical standardization. A further aim is to generate an awareness of standardization against the real background of an industrialized society, by illustrating how strongly standards influence individual areas of life and work. Our chart 1

(page 10) shows a detailed breakdown of the teaching scheme (as of 1984).

Barriers between companies and nations are being dismantled, and this is accompanied by the disintegration of entire markets and a trend towards global company and market structures. As a result, teaching and research activities in the field of standardization must be directed towards establishing an interdisciplinary and comprehensive approach to the subject.

A concept based on classification into specific subject areas and restricted to that content with a relevance to standards cannot be advocated because it is not capable of demonstrating and explaining the systematic ordering and all-encompassing nature of standardization principles and their effects.

In our opinion the priority lies in providing engineers, business managers and economists with some insight into how standardization permeates the entire range of their specific subject area. This then raises the question as to what knowledge has to be transferred in order to promote a comprehensive understanding of standardization, along with its impact and effects on enterprises and global markets (see chart 2 - *Lecture course in standardization - Teaching concept*).

*The "raw material of information" has become the decisive performance factor. The countries with competitive advantages are those that achieve success in the creation and distribution of information, in the efficient conversion of this information into knowledge, and particularly in the broad-based exploitation of this knowledge.*



## The future in teaching has begun

Let us turn to the future: we have seen that the teaching of standardization, as practised by Drs. Reihlen, Simons and Hesser, bears the distinct hallmark of their own professional experience.

The teaching of standardization has to adopt a future-oriented approach and take into account the trends noted below:

Developed, industrialized societies currently find themselves in a phase of transition from an industrial society to one based on knowledge. As a result, information has become the most influential factor in the devel-

“We wish to turn away from the traditional forms of disseminating knowledge in standardization teaching and move towards the use of multimedia in the sense of integrating different information and communications technologies (video recordings, hypertext as well as simulations and animation) in order to convey the knowledge and to structure the learning process.”

opment of such societies. The “raw material of information” has become the decisive performance factor. The countries with competitive advantages are those that achieve success in the creation and distribution of information, in the efficient conversion of this information into knowledge, and particularly in the broad-based exploitation of this knowl-

# 1 Lecture course – Standards

A detailed breakdown of the teaching scheme (as of 1984)

## Section I Industrial Standardization

### Part 1 – Design and Standardization

- 1 History of standardization
- 2 The basic principles of methodical design
- 3 Developing size range and modular products
- 4 Structure and effect of subject number systems
- 5 Methods of the reutilization of existing solutions
- 6 Standardization of CAD-systems and their environment

### Part 2 – Manufacturing and Standardization

- 1 Standardization of manufacturing techniques and equipment
- 2 Standardization and transport – standardization of material
- 3 Standardization and quality
- 4 Standardization and company information systems

## Section II National and International Standardization

### Part 1 – General information: Basic principles, elaboration and organization

- 1 Agreements and standardization as basis for human coexistence
- 2 Definition and aims of standardization
- 3 National, regional and international standards organizations
- 4 Standardization work and standardization processes
- 5 Standardization theory
- 6 Standards information

### Part 2 – Standards applications

- 1 The legal status of standards
- 2 Safety and standardization
- 3 Certification of conformity to standards
- 4 Standardization and the consumer

edge.

A society based on information and knowledge will both demand and facilitate new forms of teaching and learning. Institutions of higher education, i.e., their teaching staff, their professors and their curricula, have a formative influence on the views, motivation and performance of future managers in industry and commerce.

Consequently, we view the designing of a new teaching concept for the study of standardization as an important assignment for the future.

We wish to turn away from the traditional forms of disseminating knowledge in standardization teaching and move towards the use of multimedia in the sense of integrating different information and communications technologies (video recordings, hypertext as well as simulations and animation) in order to convey the knowledge and to structure the learning process. With the aid of multimedia technology, we are convinced that it will be possible to devise new didactic concepts for target-oriented and interdisciplinary learning. The aim is to set up a multimedia-based system of presenting teaching material, with learning aids as well as interactive practice exercises and examinations within the data network. The absence of any dependence upon time and place may also open up new opportunities for organizing and exploiting this teaching material.

One important result of this concept will be to make this knowledge of standardization available for study and further training on a global basis, i.e., for industrialized, newly industrializing and developing countries alike.

A link between a multimedia-based presentation in research and teaching will give rise to new opportunities for directly integrating current approaches and results of research into teaching. In this way, the unity of research and teaching will be intensified by a research-oriented scheme of study.

The teaching concept strived for in standardization should cover a defined skills profile leading to a recognized key qualification, either as a preparatory measure or directly enabling students to perform a particular profession.

With the aid of multimedia, a teaching service of this nature can be extended to include greater range and new quality both from the student's own university and from external universities, thereby increasing the depth of material or broadening the scope of material offered within a faculty or even in order to

# 2 Lecture course in standardization – Teaching concept, as of 1998/1999 (Autumn term 1998/Winter term 1999)

## Autumn term 1998

- 1 Introduction and history of standardization
- 2 Standardization in development and design
- 3 Standardization in production
- 4 Standardization and quality ISO 9000 series
- 5 Standardization and environmental protection ISO 14000 series
- 6 Standardization and transportation systems
- 7 Classification systems/ numbering techniques
- 8 Language-oriented classification systems
- 9 Computerization and company standardization
- 10 Applications of standardization within enterprises:
  - 11 – Technical information management
  - 12 – Modern technical product documentation

## Winter term 1999

- 1 The functions of standards departments within enterprises
- 2 Structural and operational organization of company standards departments
- 3 Economic significance of company standardization for enterprises
- 4 Standardization and marketing
- 5 Strategic implications of company-wide standardization
- 6 Macroeconomic significance of standardization - *Example: industrialized and developing countries*
- 7 Standardization and law
- 8 EC directives policy and company standardization
- 9 EC certification and European standardization
- 10 Functions of national standards bodies
- 11 Standardization in Europe and other countries
- 12 Standardization in an international context, ISO, IEC, etc.

facilitate self-study through the support of media. For standardization as a subject of study, this will present an opportunity for integration into a wide variety of other subjects at national, European and international higher education establishments. During this development, standardization may be offered as a subject of study at college and university faculties other than those mentioned above. Cooperation and networking between institutions of higher education on the basis of multimedia may give rise to new opportunities for redefining subject priorities in teaching and study and for altering an institution's profile. This development will allow the students in particular to use the curricula of other higher education institutions during their studies and thus take advantage of these extended options for determining personal specializations within their own specific courses of education.

Against this background we certainly regard multimedia as a challenge but equally as a great opportunity to get the subject of standardization become an option in a wide range of courses owing to its ability to be included as a multimedia module. Modules in the English language are especially suitable for helping standardization gain a more international character and thus become more attractive as a course of study. The standardization multimedia module may

- form part of a structured degree course;
- be an optional subject to complement and provide more detail in a particular subject specialization; or

5) Parts of this section are based upon the following essays: Empfehlungen zur Hochschulentwicklung durch Multimedia in Studium und Lehre, 15. Mai 1998 [Recommendations on development in higher education through multimedia in study and teaching, 15 May 1998]. <http://www.wrat.de/drucksachen/drs3536-98/drs3536-98.htm>

Hochschulen für das 21. Jahrhundert; Bundesminister für Bildung, Wissenschaft, Forschung und Technologie, Sept. 1998 [Institutions of higher education for the 21st century; Federal Minister for Education, Science, Research and Technology]. <http://www.bmbf.de/deutsch/veroeff/dokus/hochschul.htm>

Zum Ingenieurwesen in Zeiten der Globalisierung-Ergebnisse des Ingenieurdialogs des BMBF-Bundesminister für Bildung, Wissenschaft, Forschung und Technologie, Nov. 1996 [On engineering in the era of globalization - Results of the dialogue between engineers and the BMBF]. <http://www.bmbf.de/deutsch/veroeff/dokus/ingdo.htm>

### 3 Lecture course: standardization – A vision

#### I – Classical standardization as an instrument of rationalization within enterprises

- The history of standardization in industrial society
- Methods of standardization
- Systems of standardization

#### II – The importance of standardization for modern and forward-looking enterprises

- The management of knowledge for standardization
- Classification systems of technical product documentation
- Standardization and technical information management
- Standardization and process-oriented company organization
- Standardization as a part of quality and environmental management
- The economic importance of standardization for the enterprise
- The strategic importance of standardization for the enterprise

#### III – National, regional and international standardization and their organizations

- Functions of standards bodies
- The role of consumers and employees in the standardization process
- Standardization as part of the national, European and international legal system
- Standardization as a principle of national, European and international certification

#### IV – The importance of standardization for markets and globalization

- Standardization as a part of the information and communications society
- Functions and effects of standardization in global markets
- Network effects on markets and de-facto standards

- be used for further training purposes in industry and commerce.

This presupposes that a teaching concept be developed on the current state of science and technology by an interdisciplinary team of experts. National, European and international standardization organizations would all be able to assist by promoting and initiating the establishment of cross-institutional coordination and agreements for the exchange of multimedia study modules in standardization<sup>5</sup>.

The idea outlined was available at the Department of Standardization of the University of the Federal Armed Forces Hamburg as a project application from March 1999. The future has already begun; we are going to take part in shaping it.

### No future without research

The past was characterized by a distinct specialization in practically all the academic subdisciplines, which acted as a type of barrier between the various subject areas. This situation hinders the necessary interdisciplinary exchange that is so important for standardization as a specialist discipline.

Such a development is especially subject to criticism in view of the fact that the implementation of scientific findings, e.g., through the development and marketing of new products, affects all areas of business owing to the complex causal interrelationships in the modern industrial and information society. In order to adequately assess the multidimensional social consequences of standardization and the implementation of scientific findings in this sector of standardization research, it is necessary to overcome the interdisciplinary barriers and return to an integrated research approach. The "Anglo-Saxon study model" is especially suited to this. It is able to increase awareness of the interdependence between different scientific disciplines, promote interdisciplinary cooperation, but also convey a new way of looking at one's own academic discipline.

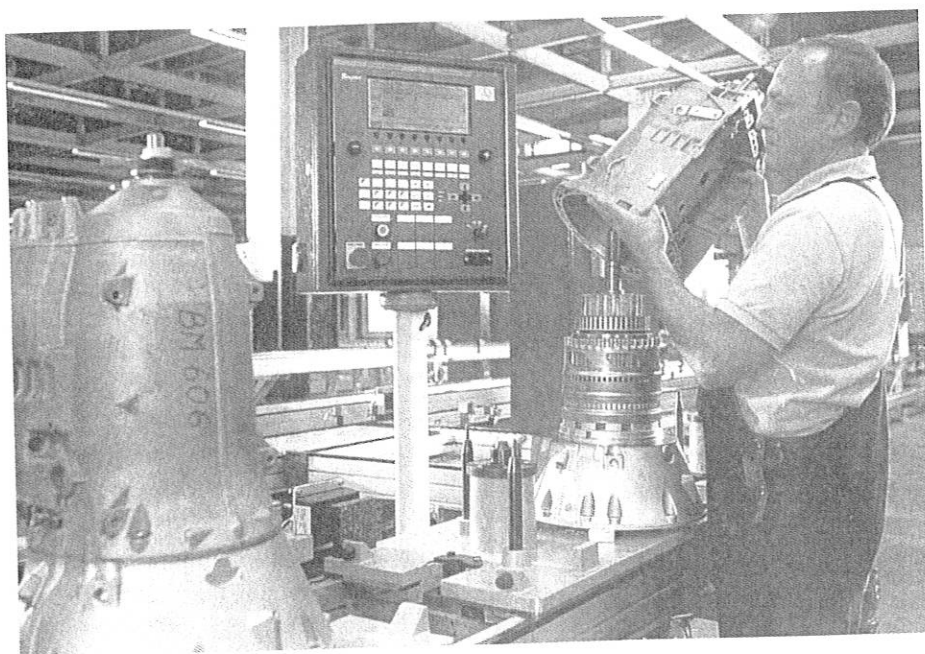
From what precedes, it has become clear that standards represent an interesting object of research in the engineering sciences, economics, the science of business management and jurisprudence alike, and that an interdisciplinary approach is essential. However, the relevance of technical standards extends beyond these subjects into the realms of humanities and the social sciences.

Consequently, it may be stated that 'standardization' as an object of investigation is relevant to the *content* of a variety of technical and economic disciplines as well as those concerning jurisprudence and social sciences, and in this respect the establishment of a new research field with an interdisciplinary approach is justified.

The need for such a measure results from the current situation of scientists involved in the standardization research sector. Many scientists are working without any contact with other colleagues conducting research into standardization. Isolation within the various separate disciplines leads in some cases to incomplete or incorrect results. In addition, there is no cross-disciplinary re-



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demical work. In the future, research in the field of standardization will take place in different academic disciplines on an increasing scale. Sponsorship by the national, European and international standardization organizations, and including industry and commerce, would certainly be in the interests of all those involved.

With albeit relatively small steps, we ourselves are striving to help establish an academic network structure and make a contribution to supporting PhD students. From 24 to 27 May 1999 the *Second Interdisciplinary Workshop on Standardization Research* was held at the University of the Federal Armed Forces Hamburg. By such means we are playing our modest part in shaping the future; the success of the event and the numbers of guests and supporters who came testified to the interest and importance accorded to the subject. □

search network either in Europe or internationally.

No specific research promotion programme exists either at the European level (5<sup>th</sup> Research Framework (EC) Programme from 1999 to 2002) or at the national level (DfG, AIF, etc.). The national, European and international standardization institutions together with industry and commerce are called upon to offer assistance in setting up a research network structure and a research support programme. They could, for example, initiate a scholarship scheme for PhD students with a maximum duration of four years' study time, and award 25 scholarships per year. This represents an expenditure of approximately EUR 100 000 per annum. Such a sponsorship scheme can be further enhanced by awarding an annual prize (e.g., of EUR 5 000) for the best aca-

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