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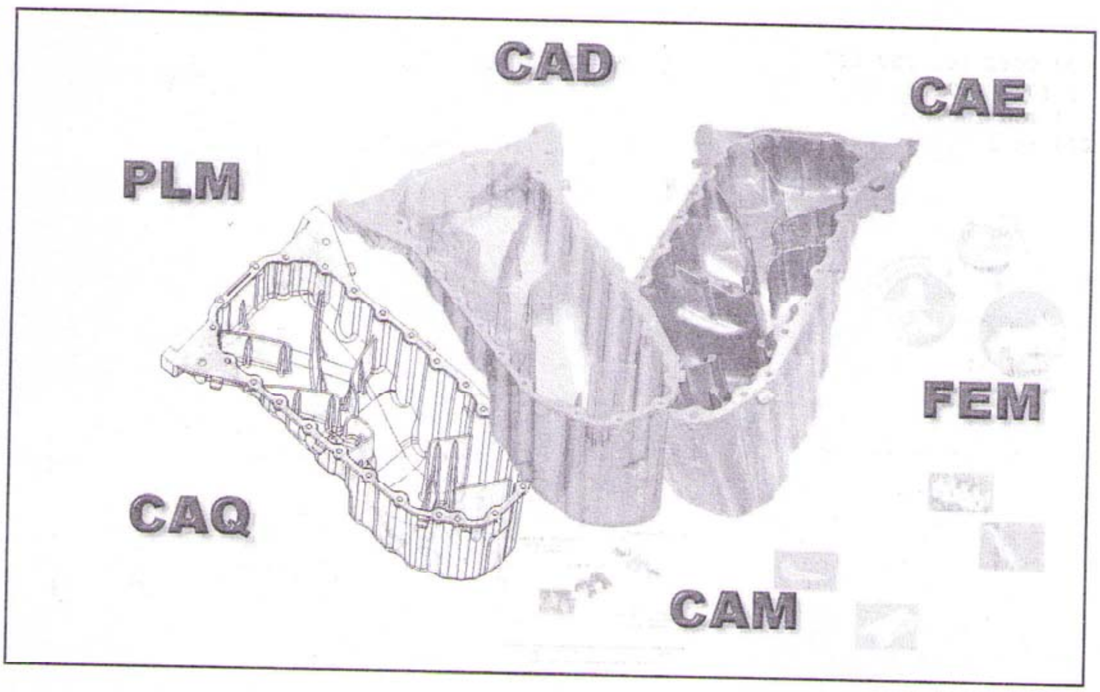
PROCEEDINGS

INTERNATIONAL CONFERENCE ON COMPETITIVE MANUFACTURING

COMA '07

The Challenge of Digital Manufacturing



31 JANUARY - 2 FEBRUARY 2007
STELLENBOSCH, SOUTH AFRICA

Organised by
Departments of Industrial Engineering &
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International Academy of Production Engineering

PROCEEDINGS

International Conference on Competitive Manufacturing

COMA '07

31 January – 2 February 2007

Organised by

Departments of Industrial Engineering and Mechanical Engineering

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About CIRP

CIRP was founded in 1951 with the aim to address scientifically, through international co-operation, issues related to modern production science and technology. The **International Academy of Production Engineering** takes its abbreviated name from the French acronym of **C**ollege **I**nternational pour la **R**echerche en **P**roductique (**CIRP**) and includes ca. 500 members from 46 countries. The number of members is intentionally kept limited, so as to facilitate informal scientific information exchange and personal contacts. In a recent development, there is work under way to establish a CIRP **Network** of young scientists active in manufacturing research.

CIRP **aims** in general at:

- Promoting scientific research, related to
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  - production equipment and automation,
  - manufacturing systems and
  - product design and manufacturing
- Promoting cooperative research among the members of the Academy and creating opportunities for informal contacts among CIRP members at large
- Promoting the industrial application of the fundamental research work and simultaneously receiving feed back from industry, related to industrial needs and their evolution.

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Foreword

Welcome to this third in South Africa International Conference on Competitive Manufacturing hosted by the University of Stellenbosch and organised jointly by the Departments of Industrial Engineering and Mechanical Engineering.

In a small world where global trade is the new driving force conquering countries and continents alike, international competitiveness is becoming the ultimate challenge of the new millennium. It requires high quality products manufactured with state-of-the-art technologies at low cost under the assumption of highly efficient operations management as well as clear corporate goals and strategy. This in turn is facilitated by and dependent on improved engineering training, education, and relevant applied research, fueled by active interaction between academia and industry.

The main objective of the International Conference on **Co**mpetitive **Ma**nufacturing (COMA '07) is to present recent developments, research results and industrial experience accelerating improvement of competitiveness in the field of manufacturing. The 70 papers selected to be delivered at the Conference deal with wide aspects related to rapid product development, agile manufacturing, operations management as well as enterprise design and integration. The worldwide participation and range of topics covered indicate that the Conference became truly a significant meeting of people striving similar aims. The event is an additional opportunity for communication between paper authors and attendees, which undoubtedly will serve as a further step towards exciting developments in the future. It also provides ample opportunities to further exploit international collaboration.

The Chairman and the Organising Committee express heartfelt thanks and gratitude to the Members of the International Programme Committee, who have given their help and expertise in refereeing the papers and will chair the technical sessions during the Conference, as well as to the authors for participating and ensuring that the high standards required on an International Conference were maintained. These thanks and gratitude is extended to our highly regarded keynote speakers.

The Chairman conveys sincere thanks to the conference sponsors for their generous support, which made this event possible, as well as to our exhibitors.

The International Academy of Production Engineering (CIRP) and the South African Institution of Mechanical Engineering are gratefully acknowledged for the scientific sponsorship given to the Conference.

Finally, the tremendous effort of the Organising Committee is appreciated. Grateful thanks are due particularly to the Conference Secretariat for ensuring the success of COMA '07.

We hope that you will find the Conference interesting and stimulating!

Prof. DM Dimitrov
Conference Chairman

ACKNOWLEDGEMENTS

Sincere thanks to our distinguished sponsors, whose generous support has contributed to success of the Conference

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Knowledge Management in Product Projects in the Automotive Industry

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Abstract

Global mergers and acquisitions in the automotive industry have left only a few companies offering a variety of brands. Shorter product life cycles have increased the number of product launches for each brand, raising the number of new product projects for companies in the automotive sector.

In a new vehicle project, covering all product creation stages, the knowledge about product and production process gained by vehicle and production tests increases as the new product project approaches the start of production. The approach in this paper focuses on potential changes to product and production process that do not go through the change management process.

Keywords

Knowledge Management, New Product Projects, Automotive Industry, Knowledge Transfer

1 INTRODUCTION

The rapid technological development and the increasing market requirements due to global competition are forcing companies in the automotive industry to offer their customers an ever growing range of diversified products despite shorter product life cycles and higher quality demands. Key to corporate success is the ability to launch new products as soon as possible in great quantities onto the market. This extends the payback period for a product and makes customers more willing to pay higher prices. To ensure business success it is therefore essential to manage the start of production fast and effectively [2]. According to a study of Magna Steyr, an automotive supplier, the shortened product life cycles in the automotive sector total less than seven years. Compared to 1990, when product life cycles used to last nine years, this means a reduction by nearly a quarter within a decade (Figure 1) [1].

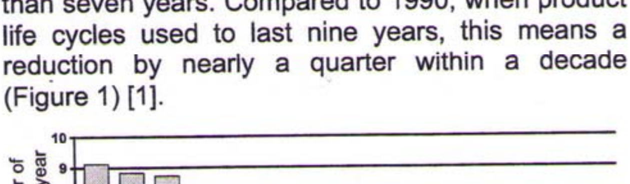

Figure 1 - Shorter life cycles of cars.

Against the background of shorter product life cycles and more product lines for each brand, actions need to be taken to increase efficiency and cut product creation time in the automotive industry. The successful coordination of the start of production poses a challenge to all industries, and no company will claim to be able to fully meet this challenge [6].

Persons involved in a new product project often have a good knowledge of potential improvements although these cannot be included into the change process for lack of time, and therefore are not utilized. To exploit this knowledge for subsequent new product projects, an approach for 'Knowledge transfer between new product projects in the automotive industry' was developed. It structures insights gained about products and the production process that did not go through the change management process, and evaluates their potential for change before integrating them into the business processes and methods applied in subsequent new product projects. Product creation processes refer to areas that generate insights into opportunities and focus on activities that help to prevent failures.

2 OPPORTUNITIES AND SOLUTION CONCEPT

2.1 Opportunities during product creation

A short payback period for investments into the development of new products or building new production sites is vital to competitiveness. To this end, companies must cut the time from start of product development to market launch (time-to-market). On the other hand, they need to reduce the time for producing a product in sufficient volume, appropriate quality and at competitive prices (time-to-volume). Shortening both periods, however, goes hand in hand with reducing the useful life of products [5]. In consequence, production starts become more frequent. The profit accumulated over the life of the new product may be reduced by 30% if the market launch is delayed by 6 months. Figure 2 shows additional effects on profit.

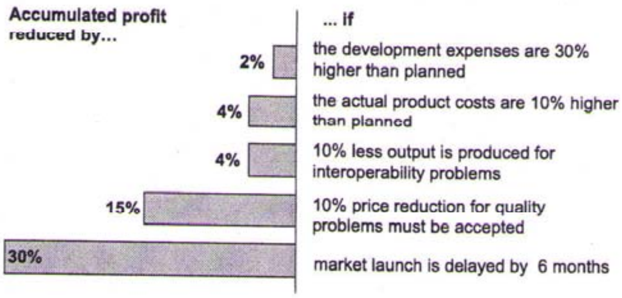

Figure 2 - Effects on product profit [8].

2.2 Solution Concept

The developed approach addresses the following problems in a new product project:

- Knowledge gained from product and production tests in new product projects is not immediately available to subsequent projects
- In the product creation process no measures are taken that 'force' project members to integrate their knowledge
- Potential changes that could not be implemented in time are not documented and cannot be considered in subsequent projects
- Independently working development and production teams prevent cross-series learning
- Only a sporadic knowledge transfer occurs between development and production
- Loss of experience due to project member turnover

To resolve the problems described above, this approach makes use of knowledge sources in the product creation process from which insights on products and the production process are gained. Only insights that have not gone through the change management process and therefore represent potential changes are considered. For example, the results of tests at certain points in the new product project provide insights on product prototypes, while the production tests offer insights on production processes. In addition, experiences are exchanged at project milestones or quality gates [3]. Then, the potential and benefits these insights offer to future new product projects are evaluated before the knowledge is prepared for use in subsequent new product projects and linked to the relevant product and production process structure. Key to the future utilization of knowledge is that it gets integrated with product and process improvement methods and procedures embedded in the product creation process (Figure 3).

State of the art in corporate new product projects are defined, standardized product creation processes using, for example, performance specifications and methods of fault prevention. The aim is to ensure the transfer of knowledge by making it part of the product creation process so that existing insights from previous new product projects are taken into account.

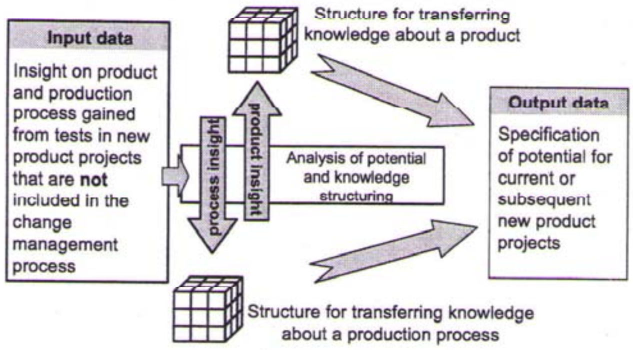

Figure 3 - Distinguishing between insights about products and the production process.

Therefore, knowledge needs to be classified so that it can be integrated by 'information frontloading' with the fault prevention processes and activities in the product creation process. New product project members must automatically integrate their acquired knowledge into the applied procedures or methods. This is to ensure that knowledge is transferred to subsequent new product projects according to need.

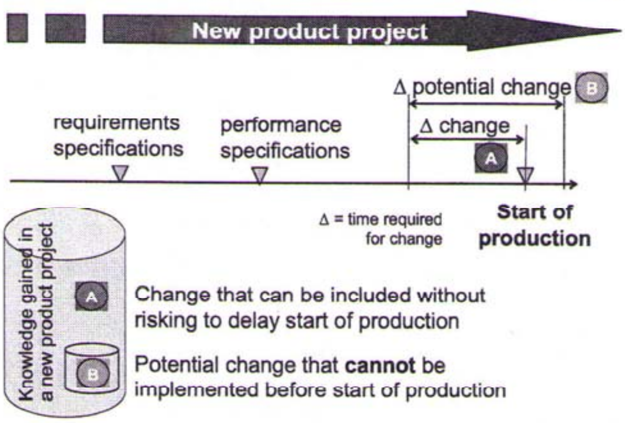

Figure 4 - Examination of potential improvements.

Insights into products and the production process result in changes that go through the change management process. But there are also many potential changes that could decisively improve the product by correcting deficiencies, or optimize the production process. The time needed, however, for carrying out potential changes would delay the start of production. Also, potential changes involve the risk of not achieving the desired result, creating an even greater need for change (Figure 4). At certain points in the new product project, the knowledge carriers know what improvements could be made, and even communicate this knowledge. However, since these potential changes cannot go through a change management process any more, they are not documented and the potential for change is not reflected in benefits or altered performance measures. Thus the acquired insights do not result in an added value to other new product projects with different players at different sites. The potential for improvement remains untapped and many mistakes are repeated.

3 APPROACH TO TRANSFER KNOWLEDGE BETWEEN NEW PRODUCT PROJECTS

3.1 Learning processes in new product projects

On the path to maturity, products and production processes pass through different 'learning phases' that systematically improve the design states [4]. In a new product project, testing plays an important role. During testing, the real maturity level of a product and the production process becomes apparent. The logic of how to translate these insights into a new design state is shown in Figure 5.

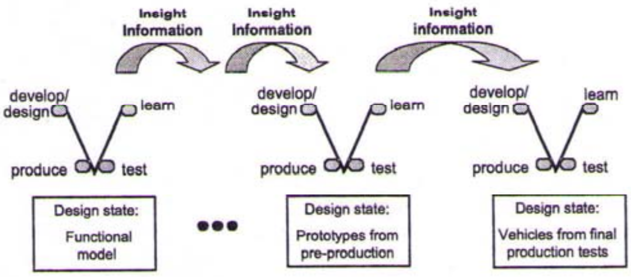

Figure 5 - Systematic learning process in a new product project.

A product is designed, manufactured and tested. The test findings provide the basis for further learning. The transfer of product-related knowledge builds only on tests of complete vehicles with components made by production tools. This is because the results from simulating, calculating and validating vehicle modules on test benches have already been fully integrated into the delta design. The closer the new product project comes to the start of production, the more findings will be generated by complete vehicle tests. Defective parts identified by reliability tests (e.g. 100,000 km run) only a few months before the start of production will not go through the change process any more. The time-to-start of production is too short for any tool changes. Here, defective parts only refer to those that do not pose a risk to the customer (unlike safety-related parts, such as vehicle steering equipment).

With regard to production tests, a distinction is made between insights from pre-production and final production tests (or try-outs). Vehicle components from pre-production tests are made with mass production tools, but not under mass production conditions (e.g. a component is made with a mass-production punching tool but not on a serial press). The pre-production tests can provide first insights into the production processes. For final production tests, components and vehicles must be made with mass production tools and under mass production conditions (e.g. at an assembly line).

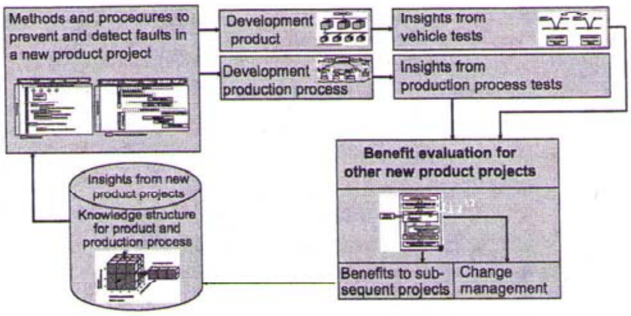

Figure 6 - Process overview.

Potential changes are identified along the product creation process based on the structure of the product and the production process. Insights into a product are gained within a new product project by vehicle tests (Figure 6), while insights into the production processes are based on pilot and mass production tests. Acquired knowledge that has not passed through a change process, must be assessed for its potential and structured for the transfer of knowledge to subsequent projects. The knowledge transfer focuses on methods and procedures of fault prevention and is incorporated to that effect into the business process for a new product project (Figure 7).

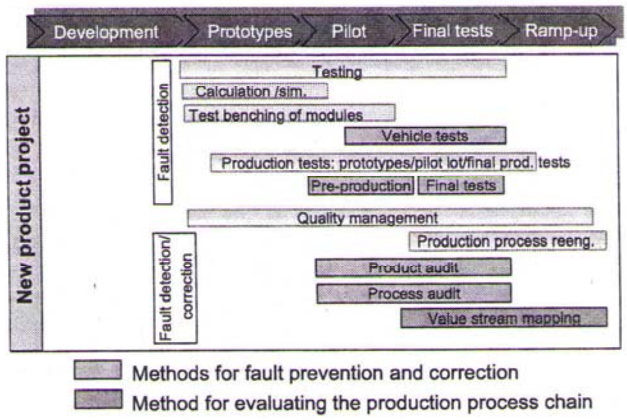

Figure 7 - Methods in the new product project to detect faults and deficiencies.

3.2 Transferring knowledge about the production process

Within the production process of a new product project, pre- and final production tests are used as elements of fault detection and correction for mass production equipment. The tests refer to the production of individual components, modules and subsystems, down to the assembly of complete vehicles. These production tests enable the project members in charge to identify deficiencies and remove them during the 'learning phase' before the next production test.

To structure the knowledge and assess the future knowledge transfer, the value streams of product families are analyzed. For example, a value stream may cover the final assembly line of a vehicle. The value stream mapping approach [7] structures the knowledge in order to visualize the production process chain and determine performance measures at individual process steps.

Customer order decoupling points in a value stream serve to organize this value stream into sub-areas (value stream segments) to reduce its complexity and facilitate the knowledge transfer. A performance specification, for example, details the process features for a to-be process that the development engineers need to take into account.

The features and performance measures really accomplished for a production process can be identified during the production tests.

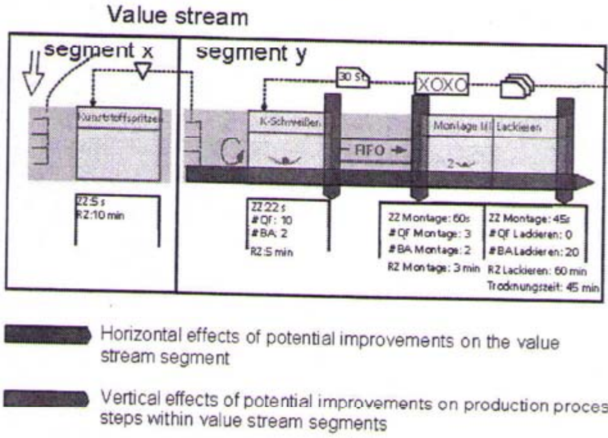

Figure 8 - Effects of potential improvements within the value stream segments.

From a production point of view (i.e. of the project's production members), opportunities to improve the individual processes are to be included in the value stream map, provided they could not go through the change management process for lack of time. The effects of these opportunities are to be assessed not only vertically for the individual processes but also horizontally for the entire value stream segment with regard to lead time (Figure 8).

To avoid faults and deficiencies, the following methods and procedures are used for the knowledge transfer related to the production process: Measures at quality gates, system FMEA 'production process', fault tree analysis, Design for Manufacturing/Assembly, and development of process performance specifications.

The acquired knowledge is structured and visually displayed by the 'Potential matrix of the production process' (Figure 9), based on the structure of the value stream segments. The matrix of a value stream segment consists of three dimensions with sub-areas:

1st *Dimension:* Performance measures/ deficiencies

If the performance measures (cycle time, setup time, lead time, quality failure, machine breakdown) at a process step can be improved, then the potential changes to the performance measures have to be expressed as a percentage. Identified deficiencies and faults are described separately. If the source of the fault has been identified, this is also documented.

2nd *Dimension:* Process steps

The value stream segment is divided into single process steps described by the technologies used for them.

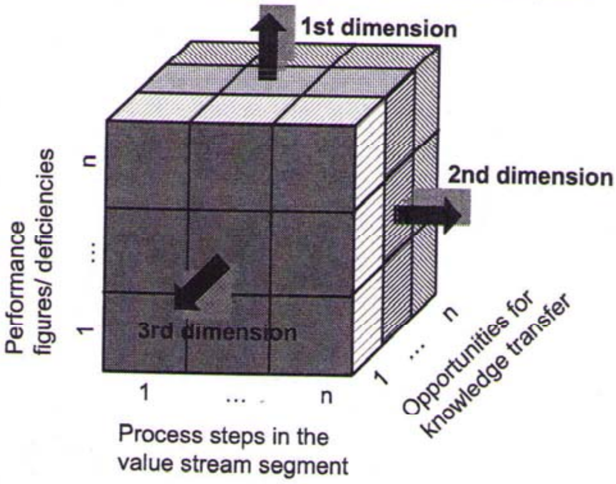

Figure 9 - Potential matrix of the production process.

3rd *Dimension:* Opportunities for knowledge transfer

The improvement potential at the process step is assigned to the relevant opportunities for knowledge transfer (development of performance specifications, system FMEA 'Process', fault tree analysis, measures at Quality Gates, Design for Manufacturing/Assembly) to other new product projects.

3.3 Transferring knowledge about the product

To acquire knowledge, the person responsible for the 'Potential matrix of the product' supports the product testing members in evaluating the test results for the complete vehicle. Based on the product structure, defective parts and deficiencies are visualized. Deficiencies of the product which can be corrected in time through learning phases as delta designs in the change management process are not to be included in the knowledge transfer. If potential improvements are identified that cannot be implemented before the start of production, the projected warranty and goodwill costs are compared to the potential change costs to assess the potential. Moreover, when knowledge is processed the potential improvements are allocated to the 'Potential matrix of the product'. When distributing the knowledge, the process owner decides what performance targets for product improvements are included in which of the new product projects, or at what stage of the project the use of methods and procedures (e.g. development of a test plan) leads to preventive measures (Figure 10). The person responsible for the 'potential matrix' must constantly check if the potential improvements of a product are put into practice.

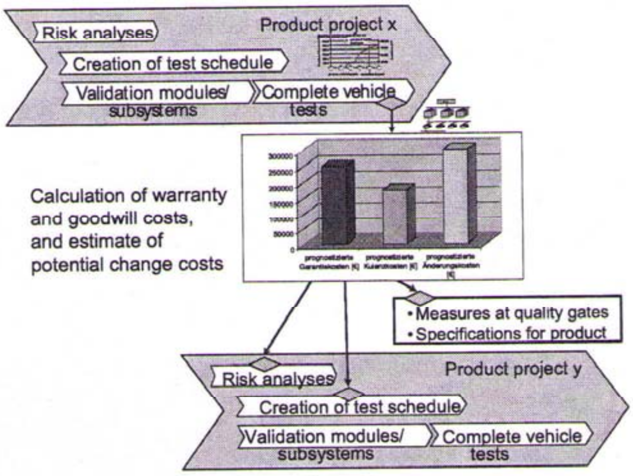

Figure 10 - Possible transfer of product insights.

After changes to the product have reduced the projected warranty and goodwill costs, the relevant building blocks (for specific components) are to be deleted.

4 SUMMARY

The 'Knowledge transfer between new product projects' approach is based on the integration of methods and procedures for fault prevention, detection and elimination in new product projects in the automotive industry. The need for actions was identified by the BMBF 'Fast Ramp-Up' study, as well as by workshops on ramp-up management held at the Fraunhofer IPA in the area of knowledge management. Another important aspect of this approach—apart from acquisition and distribution of knowledge—is that it evaluates the potential of insights about product and production process to be transferred.

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6 BIOGRAPHY

Professor Wilfried Sihn was born in Pforzheim, Germany, in 1955. He earned his doctorate from the University of Stuttgart in 1992.

In September 2004 he joined the Vienna University of Technology to work as Professor for Industrial and Systems Engineering at the Institute of Management Science. He is the head of the Fraunhofer project group for production management an logistics in Vienna.

In February 2006, Professor Sihn was invited to become a member of the „International Academy For Production Research (CIRP).