# e-Training for Critical Microelectronic Disciplines over the Fraunhofer Knowledge Network (FKN)

*Karl-Heinz Diener[1], Günter Elst[1], Werner John[2], Ludger Krahn[2], Timm Ostermann[3], Anton Sauer[1], Peter Schwarz[1]*

Fraunhofer Institut IIS / EAS[1], Fraunhofer Institut IZM[2], Johannes Kepler Universität Linz[3]

**Abstract:**

*The World Wide Web has opened up entirely novel ways of teaching and learning. To use these new chances, Germany's Fraunhofer Gesellschaft (FhG) has launched the implementation of the so-called Fraunhofer Knowledge & Learning Network (FKN). This project is mainly aimed at providing graduates, scientists, engineers and also students with latest skills in Information and Communication Technologies (ICT) much needed in industry. For that purpose, dedicated training aids have been prepared and integrated in a Web-based training (WbT) system. Starting from FKN's aims and business model, this paper describes the WbT system exemplified for using in microelectronics. A brief survey on content topics is also given.*

## 1 Introduction

The microelectronic industry and related business sectors (e.g. ICT) are extremely innovative and heavily knowledge-based. To exploit such advanced technologies characterized by ever-shorter lifecycles, the availability of the latest knowledge is mandatory. The time period during its term acquired knowledge bases correspond to the state-of-the-art, tends to become shorter and shorter. That is why application-specific expertise has to be updated all the times.

Basically, designers of integrated circuits (IC) and IC-based systems are faced with new challenges in research and development (R&D).

One of them concerns the sustained upgrading of the design methodology. Because universities' curricula need increasingly focussing on the basics, this kind of short-lived knowledge has to be integrated more and more into the content of further training.

Another important item regards the tools and systems needed for the computer-aided design (CAD) of hardware and software parts of IC and complex electronic systems. It is well known that CAD tool systems are getting more and more sophisticated, and the potential user's learning expenditure increases accordingly. Principally, that concerns the professional use of CAD tools and systems for dedicated design problems.

A third deviance results from the globalisation. To cope with the growing international co-operation, the designers have to make use of the Internet-based techniques for exchanging information and knowledge. Moreover, to ensure European companies, system houses and R & D institutes a leading edge position at the growth market for innovatively electronic products, the knowledge transfer from universities to industry and vice versa needs strengthening.

In fact, these challenges highlighted above appear simultaneously and depend on each other.

Therefore, there is an increasing demand for employee training and further training, respectively.

The Fraunhofer Knowledge & Learning Network (FKN) is intended to meet these requirements. The FKN project has been established in accordance with EU policy.

Thus, high quality skills (brainware) are the basic resources of the Information Society. Lifelong education and further training focussed on massive use of ICT, multimedia and Internet techniques are considered as the strategic areas for investments in industry.

Currently, the FKN is working as a prototype. The commercial availability is scheduled for the end of this year.

## 2 Training in microelectronics

### 2.1 The Aims

Generally, the shortage of ICT skills is now understood as a critical factor hindering the growth of the European economy. This applies, in particular, to the ICT sector itself. The advanced information technologies, and also the microelectronics as their base for the growth, suffer from both, the strongly increasing demand for ICT experts, and the lack of supplying them inline.

Therefore, the Fraunhofer Gesellschaft launched the FKN project two years ago. The outcomes of this project are mainly aimed at reducing these bottlenecks. For that purpose, and under the guidance of industry, a few leading educational competence centres have been set up, e.g., in Fraunhofer institutes. Additional educational competence centres are going to be installed with the support of the European Commission in the IST-Accompanying Measure-project LIMA (Learning Platform in Microelectronic

Applications) [LIMA01].

To meet best the demand for skills at the leading edge of ICT, the educational competence centres mentioned above will offer advanced training, primarily for designers of integrated circuits (IC) and IC-based systems, developers of electronics, and researchers in related R & D fields. Based on this approach, the basics of necessary design steps within a design flow being state-of-the-art, and the commercially available CAD tools and systems needed are assumed to be substantially known. Consequently, most of the implemented training activities can be pointed at critical disciplines of the design process. Therefore, the main emphasis can be placed on sophisticated scopes in design flows for innovative products. Such critical fields are, e.g., the design under electromagnetic compatibility (EMC) constraints, the design for test, mixed analogue/digital signal processing, and the design of radio frequency (RF) modules.

## 2.2 The Business Model

The FKN exhibits a couple of highlights with great benefits for the customers: Actually, the microelectronic related Fraunhofer institutes (7 out of 56) offer an almost complete spectrum of design and technology knowledge that is continuously updated in R&D projects with customers and partners from industry and universities. Thus, the expertise provided for the professional education and further training can always be kept at the highest level from the R&D and practical application point of view. That includes, for example, the offering of dedicated learning and training units with realistic designs to be performed by the most advanced CAD systems.

Based on networking, even interdisciplinary professional competence can be supplied.

To cope with the FKN approach and also to profit from it, the FKN set-up was organised as follows:

1. The Fraunhofer institutes act as content providers, i.e. they are responsible for

- Contents preparation and upgrading
- First user care, test and experience feedback
- Tutoring.

2. Independent from the content providers, a professional organisation has been assigned with the business affairs, i.e., it is responsible for [EITO99].

- Professional offer, guarantee and maintenance of courses
- Hotline support and certification
- Marketing.

FKN's offer to users is threefold:

- Course material on CD-ROM: Extended course books didactically prepared under multimedia constraints are available.
- Training on demand: Interactive training courses with online tutor assistance, certification by graduates, and needed commercial CAD tools outside of FKN (e.g. Synopsys, Cadence) may be used.
- Company specific solutions: The FKN contents can also be provided for proprietary training environments because the FKN outcomes are platform-independent.

Generally, the customer has to pay for these three different types of access to FKN.

Free access is given to demo versions of the courses.

# 3 Concept of the training system

## 3.1 Web-based Training System (WbT)

The composition of the Web-based Training system covers the complete administration of Web sites including the necessary functionality for organising the teamwork of involved parties.

To avoid inconsistencies and to make authors' interactions as easy as possible, the main goal of the WbT composition is focussed on an automated preparation of knowledge units (text, graphics, videos).

For that, the authors require powerful tools to accomplish their tasks optimally, e.g., content preparation, and WbT compatible designs with suitable navigation features.

Figure 1 shows the architecture of the **concept** that is based on the trinity of training provider, tutor and learner.

The provider is responsible for the working flow. He offers professional courses, and their guarantee, maintenance, certification, and hotline support. The content provider is responsible for updating and upgrading the contents of the courses.

The tutor supervises the success of the learner interactively.

Based on the learner's feedback to course assistance requested for the user, the tutor is also involved in content preparation and upgrading.
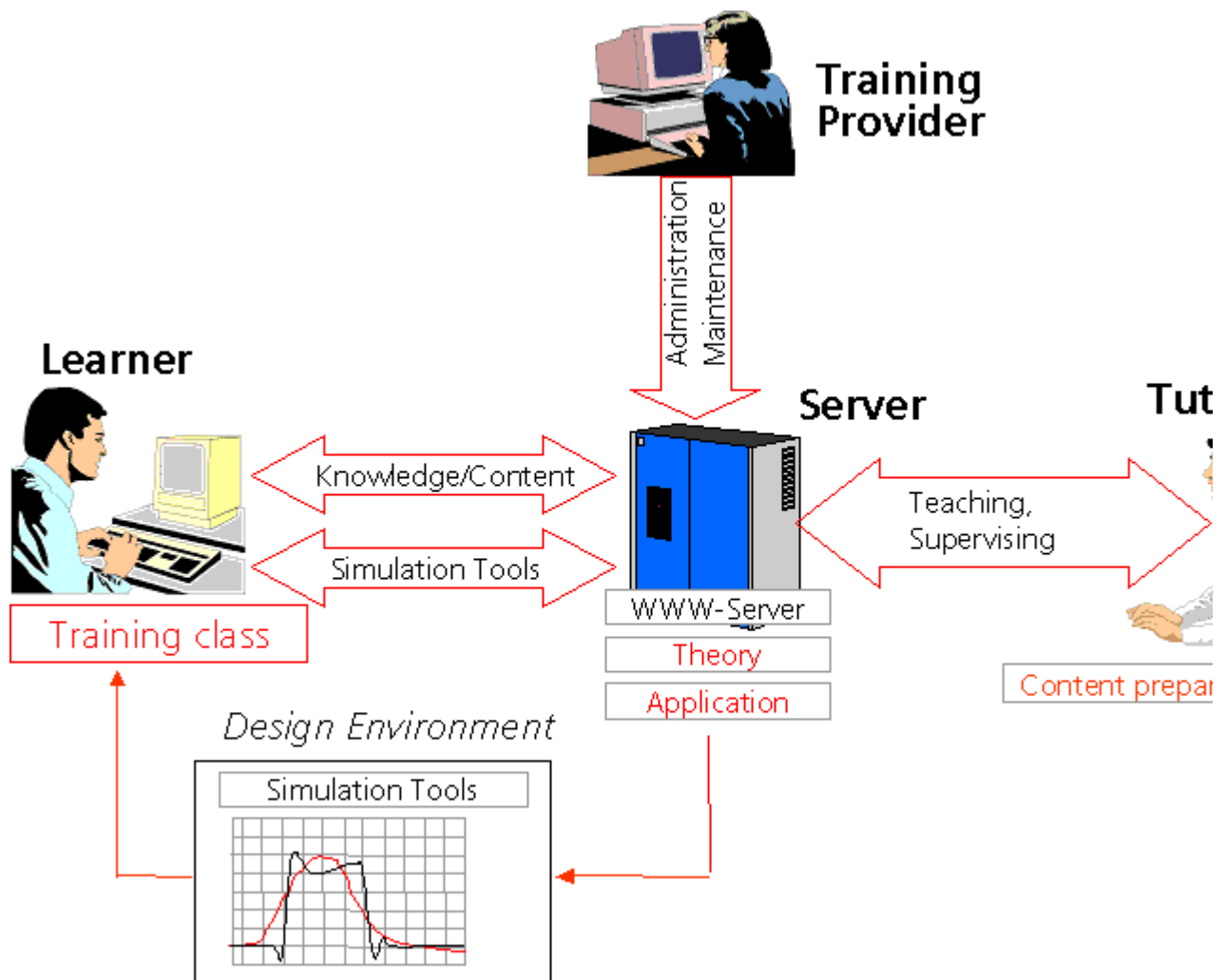
**Figure 1: Concept of the WbT system**

Figure 2 shows the architecture of the training system.

The **Content editor** represents the content provider's interface to the WbT. It is used for generating, processing, and editing the contents. An entry for online modification and updating enables to guarantee the topicality of knowledge and reduces the individual effort. Thus, a much faster creation of new pages is achieved and the transaction for a page is simplified.

Basically, the WbT is based on a class concept. This concept relies on clear patterns for content structuring. In this sense, the classes form the basis for the content generation. Actually, new contents can be created fast by a multiple use of already available classes. In this way, the required extendibility of the system is obtained.

The **ContentClass editor** is used for the generation, the change and the deletion of individual classes. It gives the Web master the facility to access the class database and to make necessary changes.

The Web designer creates content-independent styles that define the appearance of the finalized web pages.

To compose and/or change the styles of already existing classes, the WbT system has been provided with a **Style editor.** Therewith, the globally homogeneous appearance is warranted (Usability).
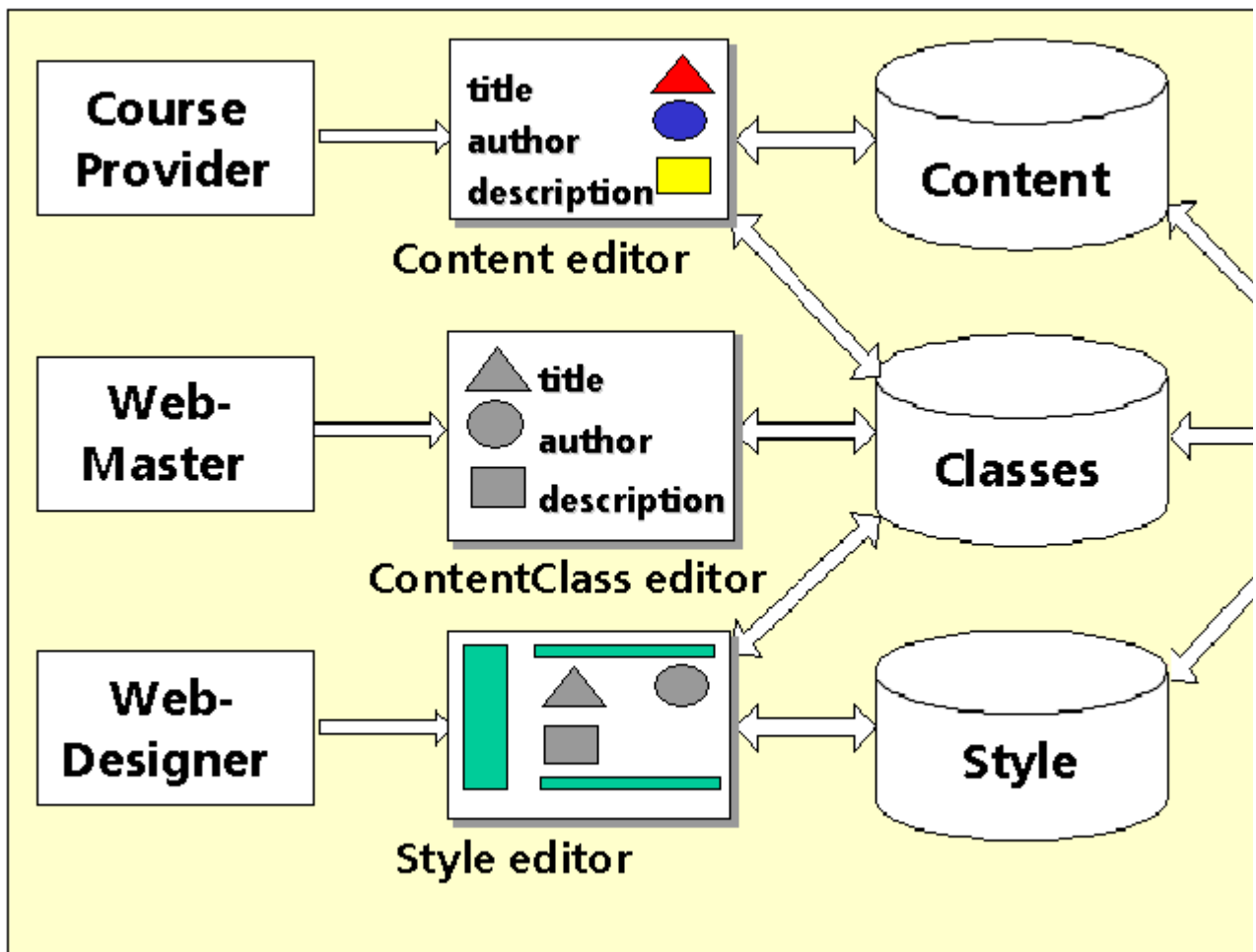
**Figure 2: Architecture of the WbT system**

### 3.2 Tool-based Content Preparation

At the moment, there is no comprehensive authoring system with distributed preparation of content units, structure editors for composing modularly usable knowledge units, and administration facilities. However, only an authoring system with these features is sufficiently flexible and allows the preferable division between both, the content to be created didactically correct and the layout to be adapted didactically acceptable (Usability).
In particular, for **distributed author teams** a software-based support has to be guaranteed.
Basically, the authoring system needs the flexibility to adapt a dedicated application scenario to an identified target audience comfortably. That means the facilities for knowledge presentation (navigation system, knowledge density, etc.) have to be available in a flexible manner. For instance, only a restricted navigation may be possible for beginners. In this case the retrieved content is provided via a stronger restricted sequence of the learning steps than in the case of a free navigation for learners with an advanced knowledge state. Consequently, the knowledge packets for beginners and advanced users can be quite similar from the content point of view, whereas the didactic preparation of the knowledge transfer and its presentation show differences.
The **knowledge generator** of the WbT system has to settle the demanded functionality mentioned above. Provided with the facilities of transferring multimedia-based applications, at least, it generates the knowledge presentation expected by the learner.

### 3.3 Knowledge Representation and WbT-based Training Platform

In the following a **training platform** is understood as a combination of representation possibilities of knowledge units, learners' facilities for navigation, and content specific integration of external tools (e.g. CAD tools). The access to a training platform focussed on CAD opens IC and system designers, R & D people, and students the chance to learn, reactivate and enhance their design expertise whenever and wherever they want. It should be highlighted that the platform-based learning process is guided depending on the user's individual level of design knowledge.
To meet the minimum standards needed for the necessary **functionality** and **modularity,** the **knowledge representation** occurs in the net and standalone (CD-ROM).
Clearly, users may locally compile knowledge units via the DownLoad procedure. A PrintOnDemand component is also required.
Naturally, integrated in the training platform the learners may expect a powerful assistance via an OnLine-

Tutorsystem as well as an OffLine-Certification.

Unfortunately, today's learning platform providers do not support these requirements [CompZ2000]. The available platforms are neither connected to design environments nor provided with the performance that is needed for training activities aimed at mastering critical design flows.

## 4 Examples of training courses

### 4.1 The Goal and Focus

Today's training courses with the appropriate educational aids are mainly aimed at the design of IC and systems for telecommunications. Due to the trend to higher frequencies in the GHz range (RF), particularly, signal integrity (SI) problems and the electromagnetic compatibility (EMC) will play a key role in the future design process. Some problems that have to be successfully tackled in IC design with RF signal processing are very similar to the needs for EMC to suppress parasitic effects such as signal delay on transmission lines.
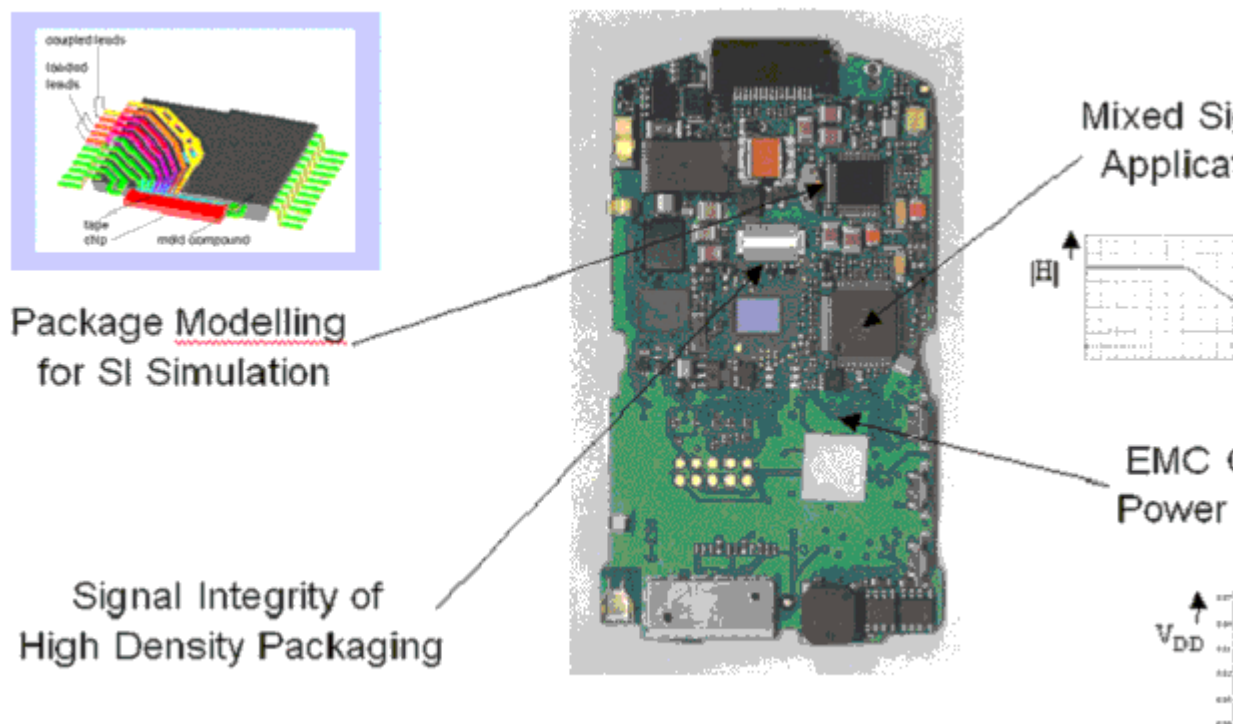


**Figure 3: A typical Application: Design of Complex RF-Modules**

Most of the modern communication systems combine analogue and digital signal processing. Especially, in the RF domain, a tight connection between digital and analogue subsystems necessitates an integrated mixed-signal design approach. This practice is also useful in the EMC analysis because the impact of crosstalk, radiation, etc. on the (mostly) digital signals has to be identified. Therefore, dedicated design methods and CAD tool support are closely related in several design steps.
Figure 3 shows an example for the interrelation of the mentioned design areas.
Actually, there is a great demand for experts who are able to settle the challenges of RF design, EMC and mixed-signal design. Thus, it is extremely useful to have available the WbT platform accessible via FKN for these three critical design scopes.
Common to the courses implemented in FKN so far is their structuring in

- A detailed description of the critical design fields, and their interrelations regarding to theoretical and practical concerns
- The underpinning of their basics by practice-related application
- The definition of a really executable high-level design flow
- An introduction into powerful hardware description languages (HDL)
- The application of the latest commercially available tools

### 4.2 The Virtual EMC Centre

The high performance required for advanced electronic systems can often be achieved with IC-based solutions only. The high processing speeds and integration densities cause parasitic effects like reflections, crosstalk, electromagnetic radiation and irradiation. To come up with marketable products these effects have to be considered within the design process already. Due to the complexity of the theoretical basics and the problems to assimilate them to the design methods and tools, the design under electromagnetic compatibility (EMC) constraints is a great problem and requires highly skilled engineers. Indeed, practical training and training aids accepted in industry have been missing up to now.

The learning and training offerings of the net-based training unit Virtual EMC Lab covers the following content (highest level):

- Introduction - EMC-Analysis of High Density Packaging
- Transmission Line Parameters
- High Speed Interconnect Structures
- Signal Integrity Analysis
- Simulation of Transmission Lines
- Calculation of Transmission Line Parameters
- Impedance Control
- EMC Adequate Layout Synthesis
- EMC Adequate System Design

### 4.3 Advanced RF Design Centre

Shorter development cycles, higher integration density, more functionality, greater performance, and stronger miniaturization are needed for the development of next generation electronic systems. Clock rates in the GHz range give rise to very high signal harmonics often causing application problems. Generally, analogue and digital approaches come more and more together. That creates a new quality of RF modelling and adequate simulation facilities. Because of the complexity of the targeted applications, e.g. mobile communication, there is a great demand for practical training and proper training aids being acceptable for industry.

The learning and training offerings of the net-based training unit Advanced RF Design Centre comprises the following topics (highest level):

- Introduction to RF Design (all levels)
- Introduction to RF Circuit Design
- Advanced RF Circuit Design
- Chip Packaging
- Chip Interconnection
- CAD-Tools

### 4.4 The Mixed-signal System Simulation Lab

The advance of mobile communication, high-speed data transmission, the application of voice and video transmission in industry and in the home area are also big challenges for R & D in microelectronics. Future mobile terminals will not only allow speech communications, but also combine multiple functions like video, e-mail and web browsing with varying transmission speeds. This widespread diversity characterises the dilemma for the designers. At the moment, an industrially accepted methodology for design, modelling and simulation is missing.

The net-based training course Mixed-Signal Simulation offers the following items (highest level):

- Mixed-signal Design Flow
- RF typical Extensions
- Model Refinement and Model Generation
- VHDL-AMS: A standardised Mixed-signal HDL

## 5 Conclusions

As a matter of fact, Europe is seriously suffering from a shortage of experts skilled in latest expertise in ICT. According to a recent survey [EITO99], more than 500,000 potential ICT jobs have no response and this number could grow to 1.5 million in few years.

As demonstrated with the examples of the Virtual EMC Centre, Advanced RF Design Centre and the Mixed-Signal System Simulation Lab, the Fraunhofer Knowledge & Learning Network offers a chance to overcome these problems in dedicated fields. The WbT platform has been provided with powerful facilities for tool-based content generation, and features for didactically acceptable knowledge representation on demand. The learning procedure can be adapted to the user's level of design expertise. The customers are offered online assistance via a tutor system. Summarizing, there is a couple of special features being typical for FKN only:

- The professional education and further training can always be held on the highest level by R&D projects with industry and universities.
- Learners are offered dedicated learning and training units with realistic designs to be performed with the most advanced CAD systems.
- Based on networking, even interdisciplinary professional competence can be supplied.

Today, the FKN is usable as a prototype. Its commercial implementation is scheduled for the end of this year.

### References:

[CompZ2000] Fortbildung im Netz, Computer Zeitung Nr. 48, 30. November 2000, p. 33
[EITO99] European Information Technology Observatory 1999, Frankfurt, 1999 ISBN 3-8163-0378-1
[LIMA01] Proposal No. IST-2000-30140 LIMA

### Author(s):

Karl-Heinz Diener, Professor Dr.-Ing. habil.
Fraunhofer Institut IIS / EAS, Zeunerstr. 38, D – 01069 Dresden
diener@eas.iis.fhg.de

Günter Elst, Professor Dr.-Ing.
Fraunhofer Institut IIS / EAS, Zeunerstr. 38, D – 01069 Dresden
elst@eas.iis.fhg.de

Werner John, Dipl.-Ing.
Fraunhofer Institut IZM, Technologiepark 34, D – 33100 Paderborn
john@pb.izm.fhg.de

Ludger Krahn, Dipl.-Ing.
Fraunhofer Institut IZM, Technologiepark 34, D – 33100 Paderborn
krahn@pb.izm.fhg.de

Timm Ostermann, Dr.-Ing.
Johannes Kepler University Linz, A – 4040 Linz
oster@riic.at

Anton Sauer, Dr.-Ing.
Fraunhofer Institut IIS / EAS, Zeunerstr. 38, D – 01069 Dresden
anton.sauer@gmx.net

Peter Schwarz, Dr.-Ing. habil.
Fraunhofer Institut IIS / EAS, Zeunerstr. 38, D – 01069 Dresden
schwarz@eas.iis.fhg.de