

# CIM Training Concept for Small and Medium-Size Enterprises (SME)

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## 1 Training - a "CIM Bottleneck"

The application of computer-aided technologies in production and the related idea of Computer Integrated Manufacturing (CIM) will decisively influence the competitive capacity of small and medium-size enterprises (SME). CIM means computer-supported processing of integrated operational processes between production planning and control, design, process planning, operations planning and scheduling, production and quality assurance. In this way CIM is a strategy which aims at the information-related linking of various operational areas of an enterprise [1].

Production problems can be reduced to the following denominator: according to the market, enterprises must produce innovative and high quality products while reducing the "time to market". Besides these market demands the enterprise is internally confronted with increasing costs, time pressure and higher quality standards. Both time and quality as well as productivity and price influence the competitive capacity. Short and reliable delivery dates, flexible and short-term reaction on customer wishes, and guarantee of high quality are required and this pressure will intensify even more.

Enterprises having up to 500 employees and annual net sales of up to 25 million marks belong to the SME group [3]. Not only are they found in different sectors, they also have a strong heterogeneity regarding the product range, the type of production, organisation and customer-supplier relationship. Especially the close customer-supplier relationship increasingly requires the application of CIM components. For many SME's this can become a question of survival [4].

The firm's objectives connected with the use of integrated information systems cannot only be regarded as aspects of information technologies. Moreover there are interdependent technical, organisational and personnel aspects. Managers as well as decision makers of the SME's often misunderstand that the "CIM capability" of an enterprise must take the decisive hurdle here and that personnel development planning is not the last link but is becoming more and more a "bottleneck factor" [5]. Therefore, a model for integrated CIM training must fulfill the requirements of target-group-oriented personnel development. It should be used for a systematic derivation of training courses in a CIM environment.

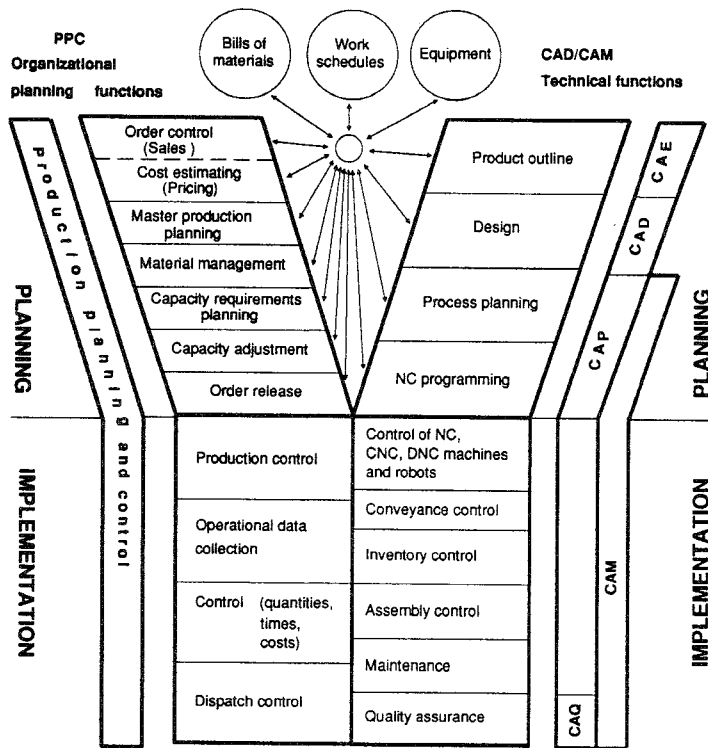


Fig. 1 Information systems in production

## 2 Draft of a CIM Training Model

CIM training - in the sense of a long-range initial and further training - cannot only be based on short-term modifications of existing initial and further training programmes. Instead strategies and models must be worked up from which modern training programmes can be derived [6].

### 2.1. Design Strategy and Models

An overlapping CIM training concept can be deduced using either [7]:

- a top-down strategy which hierarchically deduces training contents from the view of an enterprise-wide system and assigns them to the target groups or
- a bottom-up strategy which analyzes the specification profiles in the

various sub-areas and effects an enlargement within the same or even for higher hierarchical levels.

To achieve an overlapping training concept, it is necessary to use the top-down strategy in the first stage of the structuring. Therefore, a model is developed which aims to cover both personnel tasks and personnel structure. This model files or localises existing or lacking training programmes. Based on these programmes, more and more detailed training subjects will be derived in the further stages of the structuring and be documented in requirement profiles. These subjects can be used to show the changes in task structure and subjects. In contrast to the top-down analysis, the design of a model is not applied in the usual bottom-up analysis. For this reason, it can only be used for the modification of already existing training courses. Current training offers in a CIM environment may be explained by the usual bottom-up-oriented strategy. But they have two essential disadvantages:

- Because of an inadequate target group differentiation, CIM training courses do not exist or they are insufficient in didactics, methodology and substance for managers.
- Since there is no embedding in a training model, interdependencies between the individual training courses cannot be taken into account. General user training first of all imparts more special knowledge with regard to isolated tasks. Up to now only rudimentary approaches covering all areas exist.

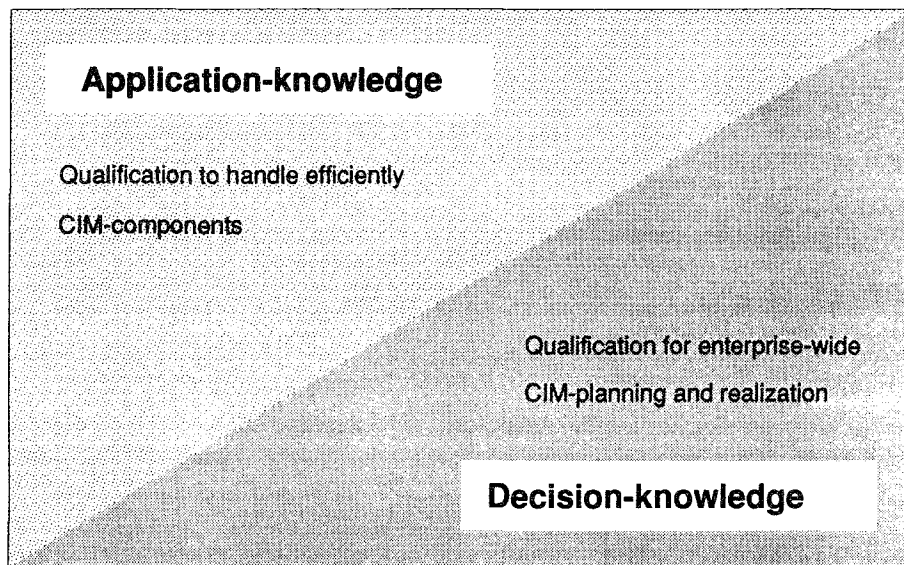
For this reason, the CIM approach with its integrative idea requires the design of a model from which concrete training courses can be derived. In the following part a CIM training model is described which especially considers the training needs of the SMEs.

## 2.2. CIM Training Model

Far reaching changes caused by the use of integrated information technologies also require altered qualifications. On the one hand, for those whose task subjects will be directly changed because of new equipment and new defined task rules; on the other hand, for those who decide on and plan the use of the technology [8]. Using the target group differentiation and a step-by-step-strategy, a CIM training model can be derived. Its training courses aim to achieve the following basic levels of CIM training:

- Application knowledge: required training to handle CIM components and use them efficiently.
- Decision-making knowledge: required training for enterprise-wide CIM planning and realisation.

The basic qualifications for CIM, described above, can be shown in an information pyramid. In designing a CIM training model, the intention was to develop an open-structured skeleton concept. This means concrete training programmes (basic curricula, training careers, didactic equipment, etc.) and its organisational execution (initial and further training, training on the job, etc.) depend on the target group and on the availability of training potential.



*operator*

.....

*top management*

**Fig. 2** Basic levels of CIM training

Furthermore, on the basis of this training model, concrete training courses can be derived and used in the course of adequate personnel development planning. This model provides systematic CIM training. In analogy to the "technical" integration of EDP systems and the "organisational" integration of tasks, a "training" integration is to be achieved.

At the level of component training the distinction between general user training and specific user training is very important. General user training should impart product-independent knowledge as far as possible. This refers to training which will be carried out with the aid of exemplary hardware and software configurations. Specific user training carried out by manufacturers and suppliers should not and cannot be replaced by this general user training. But they have particular importance because of a one-sided orientation of specific user training towards special hardware and software components.

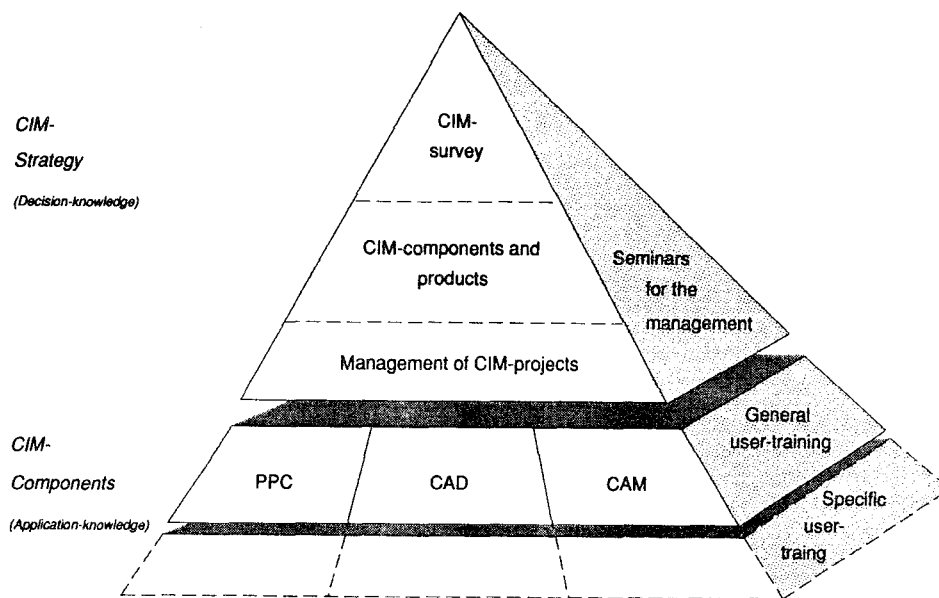


Fig. 3 CIM training modell

### 3. Development of Training Courses

Based on the training model, specific training courses can be derived in the form of courses, seminars, etc..

When compiling new training programmes, the first step is a detailed analysis and a stipulation of the training concept. A training concept should include training aims, subjects and methods. Based on this training concept training materials can be provided which are more or less constant. Nevertheless, they must be updated constantly.

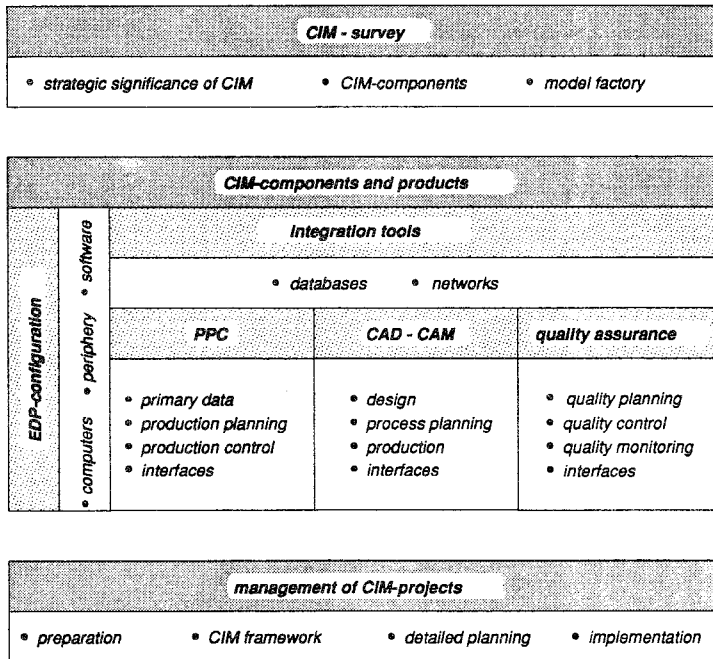
#### 3.1 Training Topic "CIM Strategy"

The "CIM strategy" training programme is especially created for managers who decide on implementation of EDP systems in their enterprises. These managers increasingly have to estimate investments related to computer-supported manufacturing though they are already overtaxed by the constantly and rapidly evolving process of innovation. This process will intensify dramatically. The continuous decrease of the "half-life of knowledge" causes a shift from initial training to further training. Long-life learning for all hierarchical levels of the enterprise is the answer to the challenges which can no longer be met with initial education and training. [10].

The aim of the training is to provide seminar participants with decision-making

**CIM - Computer Integrated Manufacturing**

**- Moduls of a sequence of seminars "CIM-Strategy for SME" -**



**Fig. 4** Subjects of seminars "CIM strategy"

support and basic strategic knowledge of the implementation possibilities of CIM components and their integration in an operational enterprise-wide concept.

Comprehensive training with the emphasis on "CIM strategy" especially designed for managers might be subdivided into three modules and include the following topics:

**Module 1:        CIM Survey**

Here the participants become familiar with the terms, concepts and effects of the CIM idea. The fundamentals of computer-supported production are taught and the strategic meaning of CIM planning is pointed out.

**Module 2:        CIM Components and Products**

Here the single CIM components their interdependencies and their significance are

explained. Decision-making support which can be used for the selection and the use of component-specific hardware and software is provided. The module "CIM components and products" is subdivided into the following seminars:

- Configuration of EDP systems
- Integration tools
- Production planning and control
- CAD and CAD-CAM
- Quality assurance

Both the fundamentals and the products will be dealt with in each subject.

#### Module 3: Management of CIM projects

Here, a planning model is illustrated which serves as orientation support in the systematic implementation of CIM components. Taking into consideration organisational, personnel and juridical aspects, typical problems are illustrated and analysed.

#### Parallel courses

To complete single seminars, parallel courses are recommended. They should be a bridge between "theory and practice". Moreover, a lively exchange of experience should stimulate discussion centering around a concrete example.

Typical subjects of these courses could be:

- Study trips to technology transfer centres and visits to model factories.
- Study trips to enterprises which already use CIM technologies.
- Experience reports of enterprises.
- Reports of management consultants as well as demonstrations shown by suppliers of CIM components.

The concrete planning and realisation of such parallel courses depend on the respectively available resources.

Besides the learning objectives and subjects, the training concept includes the learning methods. By developing manager training, the following basic conditions must be taken into account [11]:

#### Time schedule:

- Compact knowledge procurement in evening or weekend seminars.
- Broad time frame to make knowledge and experience transfer possible.
- Different study trips and CIM examples (reference enterprises, model factories, etc.).

#### Material:

- Supply of CIM concepts that are not enterprise- or manufacturer-specific.
- Distribution of high-quality training materials, i.e. qualified compendium for one's own use (transparencies).
- Essential equipment includes an overhead projector, video and flipchart.

**Instructors:**

- Competent instructors from theory and practice in a balanced proportion.
- The complex subject requires experts for each topic.

**Workshop character:**

- Small groups (approx. 15-20 participants).
- Ensuring a discussion forum between instructor and participant.
- Appealing surroundings.

**3.2 Training Topic "CIM Components"**

This training programme is especially designed for the user of CIM components. The user's task is the treatment of sub-processes within order handling. Here, the EDP-supported tools can be related to the more technical (CAX systems) and operational (PPC systems) task areas. The use of CIM components gives rise to job enrichment and job enlargement at the workplace:

- Job enrichment include the control of the implemented technology and the required operational techniques (functional qualifications).
- Job enlargement is the result of the change of operational processes and a higher competence (extra-functional qualifications).

The required training can therefore be analyzed functionally or extra-functionally. Based on the CIM training model, training programmes can be differentiated regarding CIM components in general and specific user training.

In training courses that are not product-specific basic knowledge of the CIM components' functionality in a specific area of applications is imparted. One focus of these training courses is on supra-operational knowledge. General user training might consist of three course modules:

**Module 1: Fundamentals of EDP technology**

Here EDP-related fundamentals of how to use computer supported equipment are imparted. The participant learns how to use the hardware components and the software of the system. Since these fundamentals are largely independent of the area of application and the functional range of its specific CIM component, the module "EDP fundamentals" is formulated independent of application.

**Module 2: CIM Component Training**

Here the emphasis is on the procurement of knowledge of computer-aided equipment in specific applications. Solid knowledge of the functional range of the CIM components and the underlying working procedures is imparted. To co-ordinate the user courses, the CIM training model distinguishes between the following areas of application:

- Production planning and control (PPC)
- Computer-aided design (CAD)
- Computer-aided manufacturing (CAM)



In this model quality assurance is assigned to the CAM area. Since more and more importance is attached to quality assurance, it can also be integrated into the model as an independent application area.

### Module 3: CIM Interfaces

Here the relationship between CIM components is discussed. The integration of CIM components within an operational enterprise-wide system is shown to the participants. Afterwards they will be able to recognize the technical and operational functions of order handling. Using CIM sub-chains, the essential interfaces between the CIM components are shown: [12]:

- Subchain 1: Linking production planning and control.
- Subchain 2: Linking CAD and CAM
- Subchain 3: Linking primary data management
- Subchain 4: Linking operational data collection and CAM
- Subchain 5: Linking inter-company data exchange

Users of CIM components are usually not university graduates and have had practice-oriented training. Special examples of computer-supported order handling help in teaching these training subjects. The use of concrete working tasks provides for deliberately controlled working and learning action (action-oriented learning). These working tasks should support the course participant in stabilising his working action by constructing cognitive mental models [13].

Besides exercises on concrete CIM components the use of new media (simulation, animation, hypermedia) is becoming more and more important for didactic preparation of training programmes.

## 4 Supporter of CIM Training

The main supporters of the external CIM training programmes are:

- universities and academies,
- chambers and associations,
- commercial enterprises.

It is useful to retain the training programmes of these institutions because

- training within a company might be not profitable since there are only a few participants,
- external institutions have more comprehensive competences and can offer appealing basic conditions,
- external training programmes permit those involved to meet and exchange experience,
- training within a company is linked to the available equipment,
- external training permits a consistent separation of training and daily work,
- special courses, including officially recognized graduation, cannot be supplied by the company,
- innovative technologies also need a fresh impetus from the "outside".

## Seminars for Decision Makers and Managers

The construction of CIM technology transfer centres in Germany within the scope of the BMFT Programme "Production Technology 1988-1992" is an important contribution to the extension of the future "widely effective CIM Technology Transfers" between universities and SME's. About 20 CIM demonstration sites have been constructed at various universities to give examples for CIM solutions, to offer training programmes, and to provide guidance independent of manufacturing sector [14].

Technology transfer is especially designed for decision-makers and managers of the SME's. Cooperation and guidance among chambers and associations to create both enterprise-wide training concepts and training for instructors are increasingly gaining in significance.

### General User Course "CIM Components"

Organisations like the chambers of handicrafts, the Chambers of Industry and Commerce, trade union organisations, etc. offer user courses for technical fields (CAX components). They make efforts to integrate CIM sub-chains (e.g. the relationship between CAD and CAM) within their training concepts. Training programmes with production planning and control approaches already exist but they usually do not contain a general enterprise-wide concept of a PPC system.

To develop a satisfactory training programme, it is necessary to incorporate the course modules into an integrated training concept which then allows step-by-step adaptation and extension.

## 5 Comprehension and Prospects

The training model shown should not be regarded as an approach which deals with still remote subjects. Especially in rapidly changing times instructors for initial and further training are asked to assess their training requirements carefully. Only those who have reliable information can systematically plan and economically manage such a modern training programme.

The described training concept for SME's has been developed by the Institut für Wirtschaftsinformatik (IWi), Universität des Saarlandes, within the scope of COMETT I, a research project supported by the EC. At present this concept is further developed in cooperation with the chambers of craft trades of Luxembourg, Saarland and Trier. Based on this concept, a training model within the "CIM strategy" for managers was developed in 1990 and is currently being tested by the project partners. Moreover, in COMETT II, a training model for production planning and control (Project 3017/Cb "PPC in small and medium enterprises") is being developed for, among other things, the application of a hypermedia-based tutorial.

Experience has shown that the CIM training model ensures a target-group-oriented and consistent derivation of CIM training courses. To get a systematic CIM training this model is also an aid for the integration of training programmes analogous to the "technical" integration of EDP systems and the "organisational" integration of

tasks. Enterprise-wide training concepts ensure that CIM users and CIM managers can be trained according to their specific standards. Technological shortcomings can be compensated for by means of capital, shortcomings in training cannot. Many participants have this bitter experience.

## Appendix

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# Qualification for Computer-Integrated Manufacturing

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