

III. Cooperation Model of CIM Technology Development and Transfer to Brazil

(Prof. Dr. August-Wilhelm Scheer, Dipl.-Ing. Arnold Traut, Dipl.-Kfm. Markus Nüttgens, Institut für Wirtschaftsinformatik (IWi), University of Saarland,

Prof. Dr. Heitor Mansur Caulliraux, Prof. Dr. Roger Boyd Walker, Eng. Arnaldo Ferreira Sima, Coordenação dos Programas de Pós-Graduação em Engenharia (COPPE), Federal University of Rio de Janeiro (UFRJ))

a. CIM potential in Brazil

Brazil is supposed to be the most important industrial nation in Southamerica, because it succeeded in building-up automotive industry, mechanical engineering and high-tech enterprises in the last decades. In this context, however, one mostly disregards that these industries developed in the shadow of restrictive import limitations and protective duties. E.g., up to 1991 there existed a nearly complete import prohibition on cars and computers. This means that exporters to Brazil have merely two choices: Either they construct their own production plant in Brazil or they cooperate with domestic partner enterprises. The lacking international competition caused a considerable increase of prices. A machine compulsorily bought in Brazil usually costs double the world market price. If one furthermore regards the missing discipline in planning, which causes increased dispositive and stock costs, it is obvious that the automotive plants in Brazil complain of much higher cost structures than their European mother enterprise. A liberalizing of imports by the government in 1991 abolished import limitations and reduced the duties to a certain degree, but it caused immense problems which arise with stronger competition. Brazil passes in the middle of this decade an important stage of reorganization of its industrial landscape. To stand this, the Brazilian economy needs to reach world level in industrial production.

Bottleneck number one is the lacking financing. Nowadays' high inflation rates (up to 40 % per month), the saving politics of the government and lacking support programs in research prevent the installation of necessary production systems and computer devices. The uncertainty in planning still effects large stocks, because security aspects dominate.

The use of CIM technologies can be an effective measure to become competitive. Moreover, product quality can be improved. The essential CIM-potential in Brazil will be found in human resources, e.g. the high efforts of younger professors at the universities of São Paulo, São Carlos, Florianopolis, Rio de Janeiro and other universities in the south of Brazil are promising starting points. Many of them studied in Europe, especially in Germany, and within their graduation they got their CIM knowledge. Cooperations with European institutes can keep them on state of the art. At the universities they skill very good engineers having well-founded know-how. A detailed analysis is given in *Scheer, CIM in Brasilien 1991*.

Examples of realized and promising interdisciplinary CIM research projects at universities are

- UFRJ/SENAI/IWi - Laboratório do Y-CIM-Lab), CETEMM Euvaldo Lodi, Rio de Janeiro/RJ,
- USP - Laboratório de Máquinas Ferramentas (LAMAFE), São Carlos/SP
- SABO - Sistema de Chão de Fabrica (SFC), São Paulo/SP

In the following part, the building-up of the Y-CIM-Lab is presented as a successful example of an international cooperation model. CIM-COOP is a strategic cooperation project between the Brazilian partners Federal University of Rio de Janeiro (UFRJ) and SENAI, Regional Department of Rio de Janeiro, as well as the German partner Institut für Wirtschaftsinformatik (IWi).

b. CIM-COOP: Example of an International Cooperation Model

The objective of the CIM-COOP project is to develop a model for a CIM-Technology cooperation between German and Brazilian partners, including transfer and bilateral development of technologies. It deals with the process of economical rearrangement and adaptation of small and medium-sized enterprises (SME) and includes different steps of activities coordinated by national and international partners. The cooperation is focused on planning and adjusting modern infrastructure of primary and continuing skill for employees using integrated technology for production. Its main goal is the training of employees in order to enable them to implement the concept of integrated technology for production. Thus it is intended to build-up a modern and competitive industry in Brazil focusing on small and medium-sized enterprises.

1. CIM-COOP Consortium

The compound of CIM-COOP was selected in order to guarantee a multiplication effect of all measures. Several kinds of partners are involved in the project CIM-COOP. On the one hand, two scientific and research institutes, a Brazilian and a German one, as well as Brazil's largest apprenticeship organization form the nucleus partners of the CIM-COOP-Consortium:

- IWi - Institut für Wirtschaftsinformatik (IWi) at University of Saarland, Saarbrücken/Germany,
- COPPE/UFRJ - Coordenação dos Programas de Pós-Graduação em Engenharia (COPPE) at the Federal University of Rio de Janeiro/Brazil (UFRJ), especially the Integrated Production Group (GPI),
- SENAI - Serviço Nacional de Aprendizagem Industrial, Regional Department of the state of Rio de Janeiro/Brazil.

On the other hand, there are numerous German and Brazilian companies involved. While the institutes develop concepts and thus ensure the scientific basis of the project, SENAI skills young people mainly in technical jobs. A close relation to industry is guaranteed by the connecting links between the nucleus partners and industrial companies. IWi as well as COPPE base these relationships on many cooperations within projects. The German company-group of CIM-COOP formed in the scope of a Hannover-fair's activity in cooperation with IWi, as the realization of the Y-CIM model into a demonstration plant was successfully shown. They are interested in cooperating in CIM-COOP in order to build-up and intensify their contact to Brazil. Some of them already are

represented in Brazil. The companies directly or indirectly involved in the CIM-COOP project and their connection to the nucleus partners are enumerated in Fig. E.III.01.

The national apprenticeship service SENAI is directly involved in Brazil's industry, because it represents the industrial companies' organization and is funded by them. The 27 regional departments are directly responsible for putting teaching programs into practice. SENAI works with 600 operational units of its own, such as Technology Centers, Technical Schools, Professional Training Centers, Training Agencies, Operational Training and Mobile Centers. The regional departments act in close cooperation with industries in their regions, seeking to fulfill demands for skilled labor in accordance with local requirements. These units will be used to offer courses and seminars. In Brazil, there is a strong tendency of the apprenticeship system shifting from federal hands into private charge, and SENAI is the most important private organization. SENAI and the involved companies ensure the realization of developed concepts into practice.

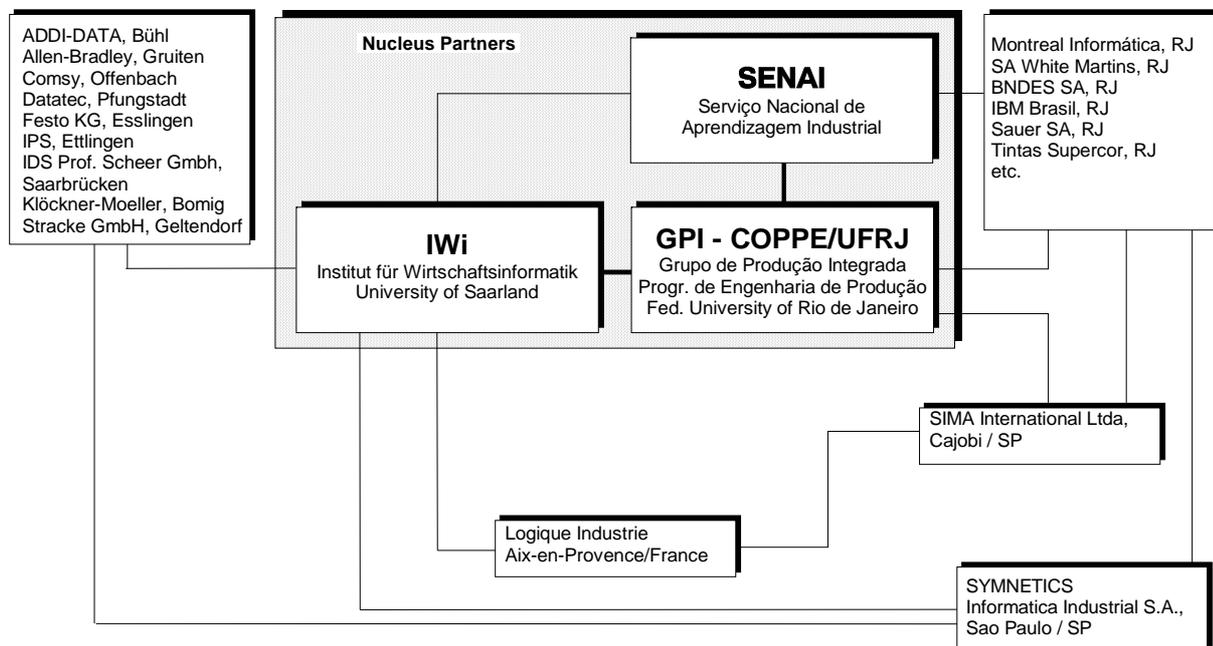


Fig. E.III.01: CIM-COOP Consortium: nucleus partners and involved companies

2. CIM-COOP Strategy

Today existing training concepts for SMEs lack an offer for the target group of decision makers. An enterprise's management has the main task to define medium and long term goals and make the decisions to reach them. Beside the technical and financial aspects, the role of training and guiding employees is increasing more and more. These tasks are part of strategy aspects and are called decision-knowledge and employee guidance. As industrial practice shows, the target group's acceptance of computer aided production technologies is a basic condition for an increasing EDP-use in enterprises. In order to have an overview on computer aided

technologies, a decision maker has to have compressed basic and special knowledge. Therefore, he should not be taught in detailed knowledge, but in strategic knowledge in order to be able to calculate the consequences of possible decisions.

Such a concept, which is especially directed to qualifying special target groups when introducing and applying CIM components in small and medium-sized enterprises, was developed at IWi. This qualification model follows strictly the integrative idea of CIM. As an open-structured frame concept, it can be used as an aid to develop concrete adapted qualification measures. The seminars for decision makers are divided in three sections becoming more detailed from top to down, as the "training pyramid" in Fig. E.III.02 elucidates. Based on the qualification model, concrete qualification offers such as trainings in the scope of courses and seminars are deducted. In order to ensure a well analyzed and detailed training concept, mainly timestabil training materials are composed, which are supplemented by topical information.

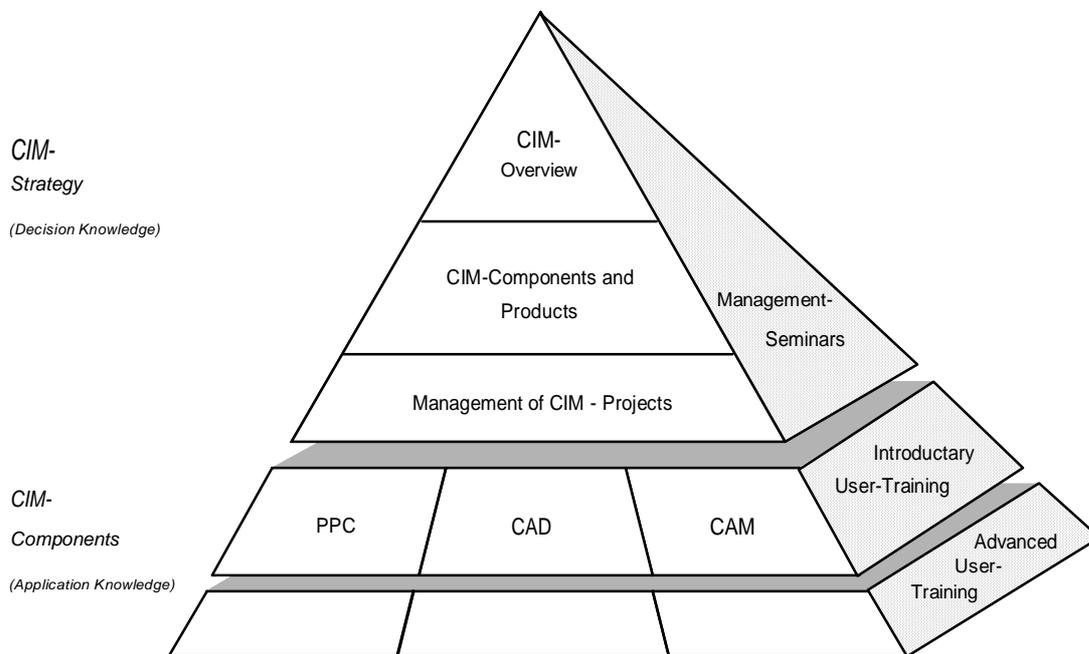


Figure E.III.02: Training pyramid

source: Nüttgens, M.; Scheer, A.-W.: *CIM-Qualifizierungskonzept für KMU 1991*

An international project aiming to transfer CIM technology always has to regard the basic qualification concept, which has to be adapted to local circumstances in a first step. Very important is the exchange of personnel, so that the objectives and problems can be discussed directly. Up to now, mainly the exchange on university level was supported in the scope of pure research projects. Technology transfer requires the exchange of personnel applying the technology and imparting the knowledge to others in order to obtain multiplier effects.

In the case of the CIM-COOP project, following steps are gone:

❑ Exchange of multipliers:

There is an intensive exchange of scientists of all levels. The duration lasts from three weeks to six months. The Brazilian groups visiting Germany stay most of the time at CIM-TTC Saarbrücken, but numerous visits to other German CIM-TTCs, institutes and exemplary companies are organized. E.g., in 1993 five Brazilian post-graduate students had a six months stay at IWi in Saarbrücken in order to get theoretically skilled in CIM technologies and concepts focused on the Y-CIM model for industrial integration. Practically the team was trained on a Y-CIM prototype plant, which demonstrates the highest level of automation. Beside many visits, they took part in several industrial courses and thus some promising contacts were established. Another stay of Brazilian post-graduates at CIM-TTC Saarbrücken qualifies them in production management methods and in using software tools based on the ARIS architecture (see *Scheer, A.-W.: ARIS 1992*).

❑ Qualifying decision makers and management staff:

The post-graduates additionally skilled in Germany hold courses and seminars at the university and at SENAI's schools in the state of Rio de Janeiro. For the skilled persons, it is very important that they can immediately be trained on the use of real CIM components, in order to get practical demonstration of the theoretical skill before. The exemplary demonstration facilities being available in the Y-CIM-Lab at CETEMM Euvaldo Lodi, SENAI's largest training center in Rio de Janeiro, are presented in the next point.

❑ Consulting companies in the state of Rio de Janeiro:

Companies of the state of Rio de Janeiro that are interested in integrating components get consultation by the partners of Euvaldo Lodi's Y-CIM-Lab. This consultation covers the conceptual methods as well as the technical methods up to questions of implementing the prepared methods. Current business processes are modeled by using the ARIS architecture. They are analyzed and subsequently optimized.

❑ Diffusion of CIM concepts and technologies in Brazil:

In order to expand technology transfer to the other locations in Brazil, the qualification concepts are adapted to the local circumstances. This step will be decisively supported by SENAI, because it is the ideal partner with its country-wide, regional and local structure.

❑ Development of technical training methods and integrated quality systems by using newest technologies:

In order to support the diffusion of CIM, self-training software systems will be a useful mean. The nucleus partners IWi, COPPE and SENAI develop those self-training systems, especially using multi media technologies. Quality is a decisive criterion of being competitive in the market and has to be integrated in the production process. New technologies can support to guarantee quality, if they are integrated in business processes. Combinations are also imaginable, e.g. in the scope of one step of CIM-COOP project is planned to integrate the quality check images of the Y-CIM-Lab into multi media applications, where they are

worked up in training systems. The statistics of the evaluated images give conclusion on the produced quality.

3. CIM-COOP Demonstration Facilities

Beside the theoretical skill, the practical use of devices plays an important role. To enable the Brazilian partners to demonstrate different levels of automation, an integrated Y-CIM prototype is transferred from Saarbrücken to Brazil. It is installed in the Y-CIM-Lab at CETEMM Euvaldo Lodi, SENAI's largest training center in Rio de Janeiro. This production-line represents the highest level of automation beside the semi- and non-automated production devices already installed, e.g. CNC drilling and milling machines, PLC controlled robots, handwork places. Thus, combinations of different components can be demonstrated, and real existing configurations can be indicated by referring to a company's conditions.

The Y-CIM prototype had been developed within a project of IWⁱ in cooperation with ten different industrial companies. It strictly bases on the Y-CIM model (see Fig. A.01). The idea is to manage a computer aided information transaction, including all stages of production. The integrated order processing is demonstrated, considering order entry, construction, work scheduling, manufacturing, quality control and finally shipping.

Exemplary, this CIM demonstration model produces buttons consisting of four separate parts which are composed. Flexibility is demonstrated by the choice of the basic color and an individual name which is printed on top. The CAM-components of the Y-CIM prototype were transferred to Rio de Janeiro and re-installed in the Y-CIM-Lab at CETEMM Euvaldo Lodi (see Fig. E.III.03).

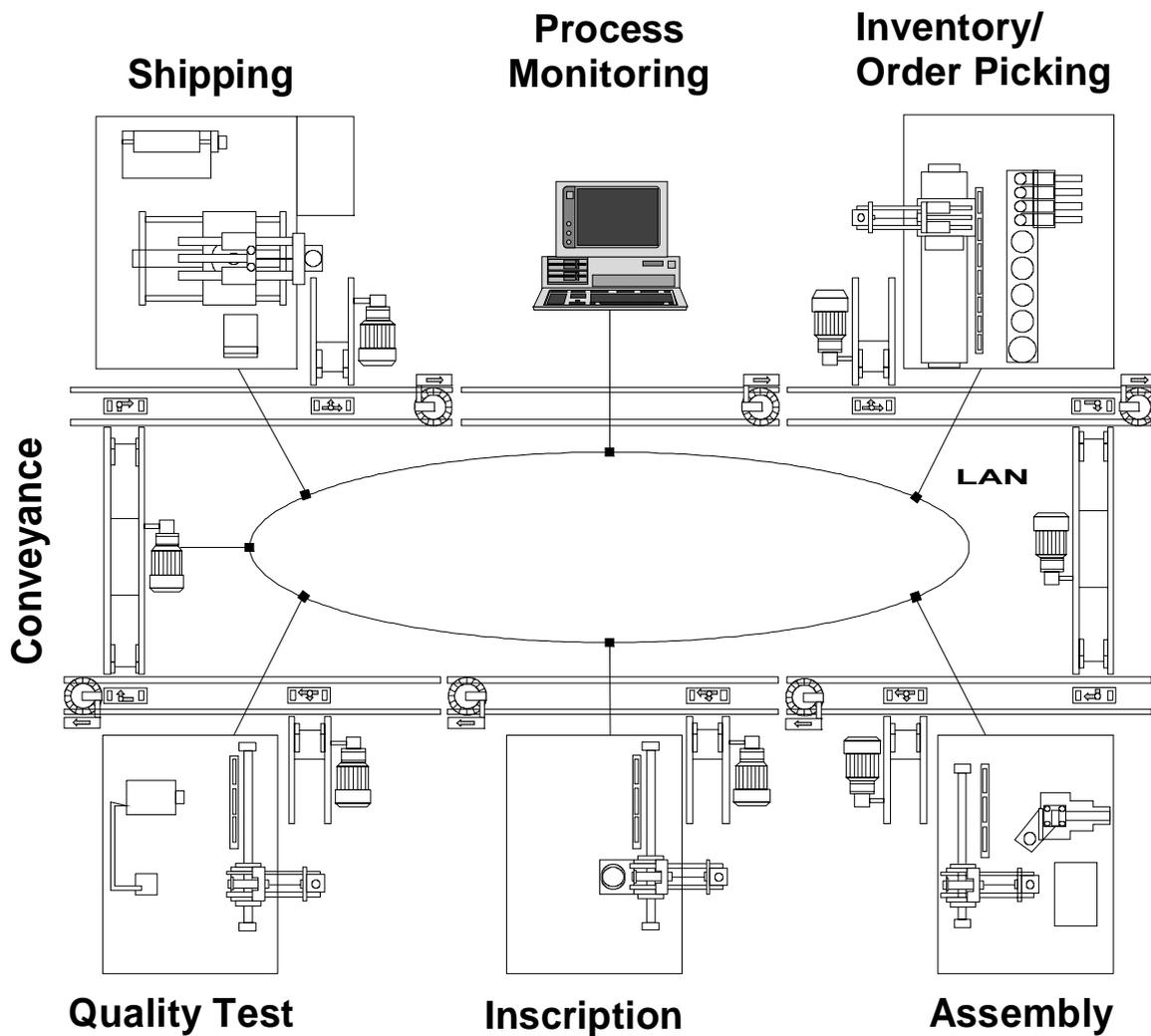


Fig. E.III.03: Concept of the Y-CIM prototype installed in the Y-CIM-Lab at CETEMM Euvaldo Lodi, Rio de Janeiro

The Y-CIM prototype's concept realizes the integration of computers and control systems as well as varied CIM-application components based on common networks and standardized interfaces. The main item of the model fabric is represented by a production line, consisting of five stations and a connecting conveyance system. Four different Programmable Logic Controllers (PLC) steer the manufacturing processes in compliance with the data of order, construction, parts list and working schedule that are delivered by systems of other companies.

All actions are coordinated and monitored by a process monitoring system, which gives the order to the conveyance system in order to refer it to a palette being not in use at this moment. The order contains the chosen button color and the individual name which will be printed on it. The first station is an inventory station, which contains the single parts that are necessary for the production of a button. After picking the single parts and putting them on a transport palette, they are conveyed to the assembly station where all pieces are formed to a complete button. Subsequently, the ready button is brought on the same palette to the inscription station where an automatic arm puts the button on a turnable table. Using a camera and a low level image processing system, here the button is turned in a right position so that the individual name can be printed in a writing field. The

button is moved along below a print head. When finished, it is put on the palette and is conveyed to the quality station. Here the image of the button is captured by a camera and analyzed in an image processing system which decides, if the name is written correctly in the writing field. Fig. E.III.04 shows the layout of the button. Catching such an image, the image processing system makes conclusions on the produced quality. With a positive result the button is given to the shipping station, else it is rejected at this station. The CAQ component is planned to be extended by means of multimedia.



Fig. E.III.04: The Product of the Y-CIM prototype

In the informationtechnical view, the Y-CIM prototype "button plant" represents the control level and the operational level. In a next project step, the production Leitstand FI-2 will be installed, which will control several working cells. Flexible planning strategies enable FI-2 to regard the needs of different productions. Aims like the reduction of transaction times or the improvement of equipment utilization times can be realized easily. It calculates the time scheduling of the orders and their operations at each machine and each working place, including non-automated handworking places. FI-2 is described in detail in chapter C.III.a. To schedule the entire resources (personnel, machines, tools, material) the resource Leitstand RI-2 will be installed too and support the logistic planning. The Y-CIM prototype will be one of these controlled cells, but the one with the highest level of automation integrating diverse systems. The other cells are CNC Labs containing automation machines. The planning level will be completed by the integration of PPC and CAD systems. Fig. E.III.05 shows the planned structure of CETEMM Euvaldo Lodi's Y-CIM-Lab. In order to work out the concept, each cell is modeled by using the ARIS architecture (see *Scheer, ARIS 1992*).

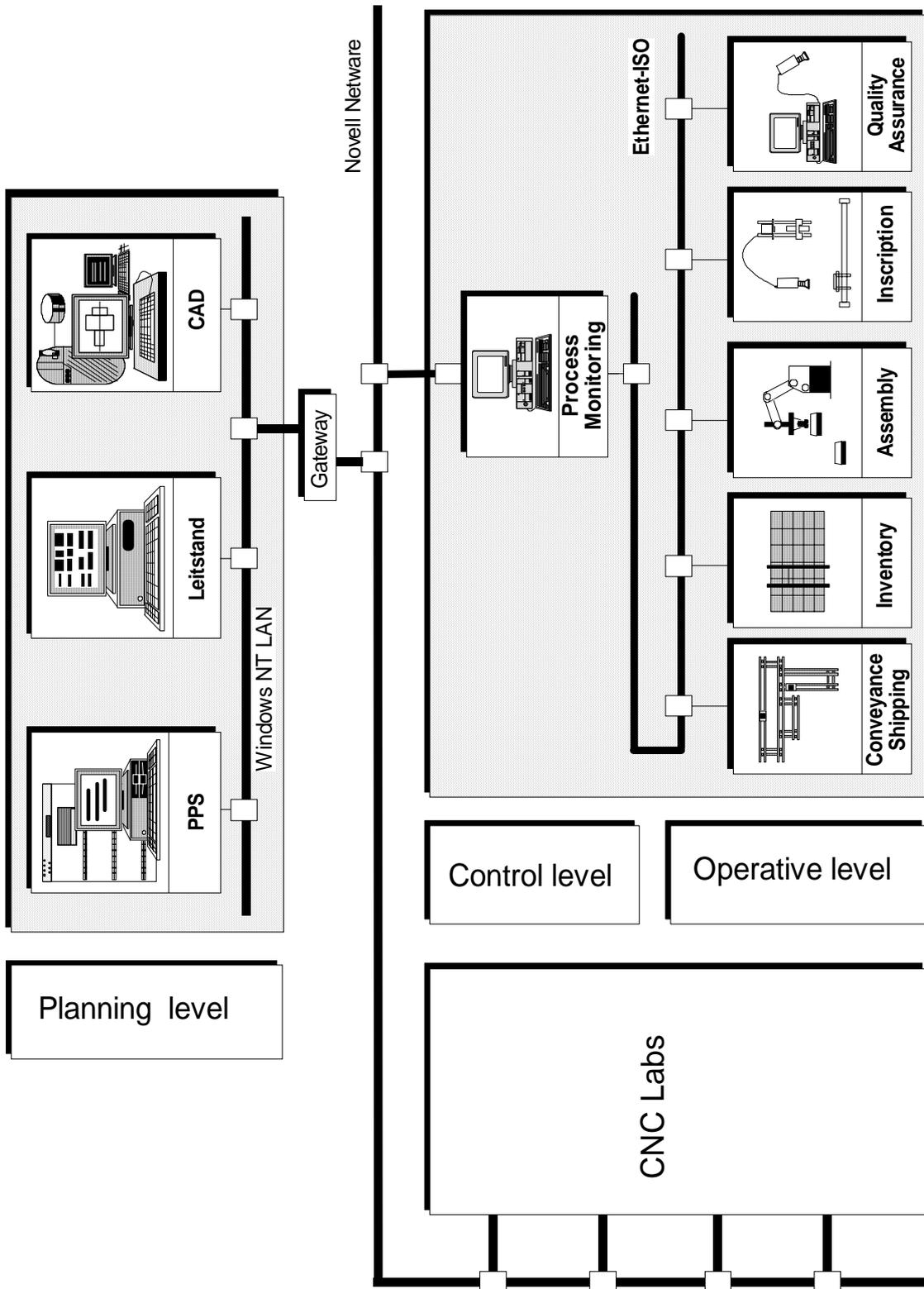


Figure E.III.05: Planned structure of Y-CIM-Lab at CETEMM Euvaldo Lodi, Rio de Janeiro