# COMPUTER INTEGRATED PRODUCTION IN PRINTING

Helene Juhola, Asta Bäck, Pekka Korpiharju, Olli Kuusisto, Janne Pesonen
Technical Research Centre of Finland, Graphic Arts Laboratory

**Abstract:** Today, automation and computer technology are generally applied in the industry to increase the productivity of human work. In the development of future production systems the automated and manual production stages should be integrated into effective wholes. The solutions to achieve this goal are usually defined as CIM applications. Is CIM just another buzzword or does it have a meaning and applicability to the graphic arts industry?

This paper gives a review of the studies made to define the CIM concept in printing companies. Many models were needed for. It was necessary to model each company's operations and to define the nature of their relationships (functional, informative, control). The information and material flows were analysed.

## Introduction

In the manufacturing industry Computer Integrated Manufacturing (CIM) has been a major issue for several years. In Finland, the Central Association of Metal, Machine and Elektrotechical Industries has made many companies familiar with the concept and technology of CIM. CIM has been promoted both in national and international research projects.

This aroused our interest and we, at the graphic arts laboratory made a study last year to clear up the following things:

- what is the essential content of CIM
- are the basic ideas of CIM applicable to the graphic arts industry
- what are the practical benefits
- is it possible to produce general CIM strategies and operations models for the graphic arts companies or are the CIM solutions individual for each company in our industry as they are in other industries.

The study was made by collecting information of solutions in other industries, especially of the metal and machine industries, analysing the differences between these industries and the graphic arts industry and making case studies in four printing companies.

The researchers represented printing and post-press technology and production control, which was reflected in the goal setting of their work. Our aim was to find solutions for the business as whole not to study the applicability of single techniques.

Besides Finland activities applying CIM-technology to the graphic arts industry have been taken at least in Switzerland.

The basic concept of CIM has been defined in Finland as the development of business by computer and automation techniques. It is strongly emphasized that this is not a separate, clearly definable technology but rather a concept, that guides business development so that the operations from the order down to the delivery make an efficient integrated whole. In the abbreviation CIM only the I is totally correct. C is not always necessary and M is too constricted.

**The use of automation and information technology**

Computer and automation techniques are mainly used in the following four areas:

1. Administrative ADP
2. Data systems which support production (for instance production planning and control systems)
3. Production systems ( for instance text and image processing systems, CAD systems)
4. Machine automation and mechatronics

The above mentioned systems have developed at different times and that is why their coverage and strategic importance today are different. Integration of the different systems interests both the manufacturers and the research people. Companies and businesses should take the challenges and requirements of integration into account as early as possible in their plans for future development, because subsequent integration afterwards is usually much too difficult.

Let us have a look at the present state of the production systems and machine automation. The CIM capabilities of prepress are reasonable as far as computer technology is concerned. The work is done mainly by computer systems or by computer-controlled high power peripheral equipment. Production data can already be gathered with most system components, although it is seldom assessed or used further. Production data is recorded and maintained in the same way as in data banks. It is, however, not easy to use this data because of the great number of manual interventions in the dialogue procedure for author corrections, estethic adjustments or last-minute changes.

The CIM capabilities of the printing phase are good if provided by the newest four-colour heat-set rotary and sheet-fed presses. Without any major changes they can be considered as CIM islands. This is not so with older presses and special printing machines.

Automation is also increasing in post-press phases. The newest equipment is electronically controlled and managed by the computer. Printed products are personalized mainly by computer-controlled ink-jet printers. Although individual units are CIM-capable, the great flexibility of the production lines may cause problems.

Integration of these separate islands is the main problem. How should this be done with software that is not always compatible and with different kinds of operating systems? Should integration be developed on the operating level or on the processing level?

Integration and CIM solutions can be carried through in a number of different ways. The different types of CIM may be classified into four groups /2/:

1. The integrated systems approach

- puts strong emphasis on the importance of computer integration and information techniques, on expensive solutions although their benefits are not always known or fast

2. The focus-on-factory approach

- puts emphasis on flexible manufacturing techniques, short series and short turnaround times, which reduce need of integration (examples are found in Japan)

3. The build-on-what-you-have approach

4. The human integrated manufacturing approach

- the employees form an interface between the automation islands
- the idea is that people control the advanced production machinery and not vice versa

## Corporate analyses

Research and development in CIM can take place at different levels, i.e. generic, industrial or corporate levels. Our aim was to examine the applicability of CIM at the industrial level through the corporate level (Fig.1).

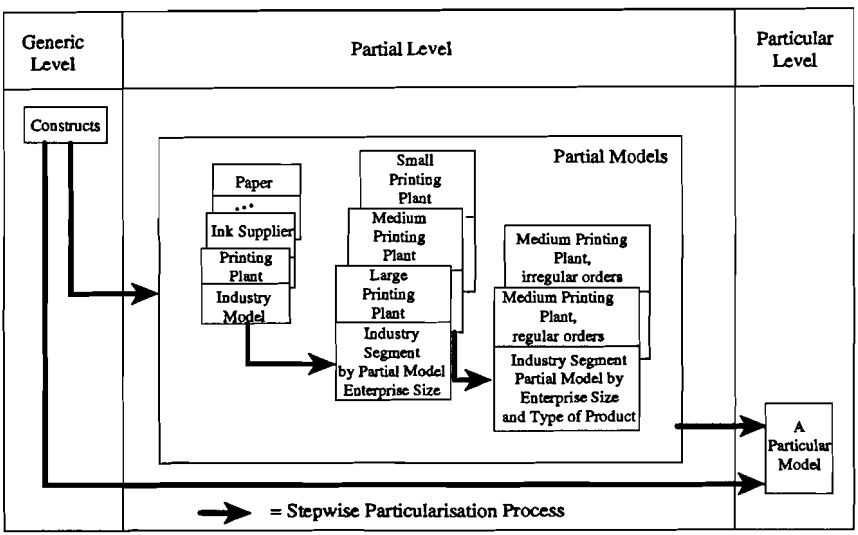


Figure 1. The levels of CIM (in the graphic arts industry).

We made case studies in four printing companies representing different kinds of production: books, school-books, magazines, forms and direct advertising products. In each case one to six calendar months were spent on the study, which was begun by an overview of the company. After that, we concentrated on the problems in the material and information flows. All the detected problems were studied in depth. The goal was to find potential targets of development, especially in CIM. We proposed a CIM strategy for one of the companies .

Research was done by interviewing the key persons of the companies and by gathering data from the companies. The actual collection of data was done by the companies themselves. To get identical information from all of the companies would have required too much time, because all of it was not available at reasonably amount of work. In result, the basic information was not complete in all cases.

Depending on the size of the firm and depth of the study, 5-20 key persons were interviewed, including, for example the managing director, the sales manager, the chief buyer, the production manager.

The studied companies represented mainly two production types (regular orders, irregular orders). We found, however, that, for example, the production of magazines is not as easy-to-control as one might think. In regard to the economy and marketing, it is more advantageous as one contract calls for several deliveries. In production, there are many things which are relatively difficult to control. The original material comes from several different sources and the product does not get it's final form until rather late just before the production. The number of pictures and detailed information of the product are needed for invoicing, and special arrangements must be made to collect this data.

The gathered information was documented by the SADT technique (Structured Analysis and Design Technique). The description of this technique is in Appendix 1. The SADT can be applied in the analysis of both systems to be constructed and in the analysis of existing systems. The technique can be applied in the early phases of system analysis but it is not very applicable in software design. The descriptions made in the graphical description language contain hierarchic data and material flow diagrams. The basic elements of the SADT are shown in Figure 2.

The main purpose was to find out about the data flows in the control and integration of the companies. During the study, it was found that one should be very careful when combining data and material flows into the same picture, because pictures tend to get quite confused. Essential with the description technique is to divide and relocate the operations correctly. In some cases it was rather difficult to distinguish the controls from the inputs. The description of the present state has to be outlined properly in relation to the number of details and the amount of work, so that the benefit will be in relation to the investment. The diagrams are useful, after they are improved enough.

The descriptions help understand the present situation, showing the target state in a comprehensible form. On this basis it is possible to find a realistic path from the present to the target.

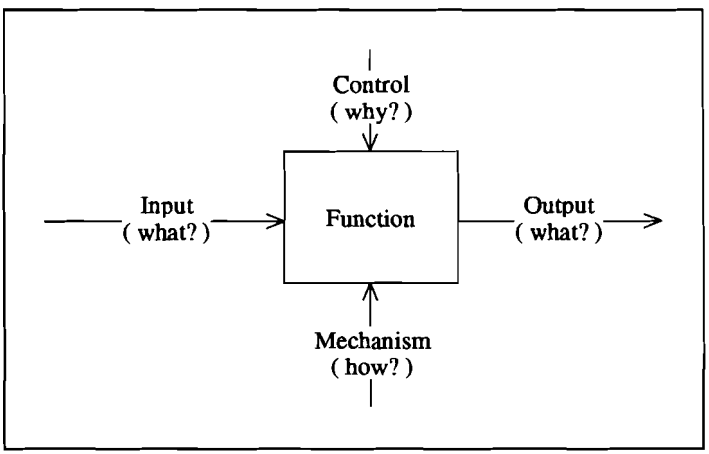


Figure 2. The basic elements of the SADT.

**Observations made on the corporate analyses**

Identical or similar operations are naturally found in different companies, although they are differently located. A good example of this is production planning (production planning = product design + how to manufacture + when to manufacture). In book production, there was a separate production planning, while in magazine production there is very little production planning (because the principal features of the products are identical), and for the difficult direct marketing products, production planning (= how to manufacture) took place at the printing press.

There is a distinct difference in production planning, compared with the metal industry, in which the complicated structure of the products requires good production planning. A principal part of CIM is to link the desing, planning and manufacturing (link between CAD and CAM). According to our study, this is the area that should be given more attention in the companies. This requires integration of the information transferred as elements of the product, instructions and work orders.

The control methods are not comprehensive nor are they fool-proof and it is not sure that they ever will be, either. According to our study, this is another area that requires further research. Improvements are needed in this area for the advancement of CIM in the graphic arts industry.

Computer techniques were applied in varying scope and for different functions in production control and management. The problems were, however, in many respects identical, meanig that wrong or imperfect control information was transferred. Oversized paper stores were also typical. These things show that the information system itself does not guarantee the efficiency of the operations and the ideas behind the applications are extremely important.

## The results and discussion

The study provided us answers to the questions we had posed. In the graphic arts industry the essential task of CIM is:

- to handle the whole chain from the customer to the customer
- integration to provide for a fast and economically effective overall operation
- to choose the measures freely

CIM is applicable in the graphic arts industry. The attainable benefits from CIM are fewer mistakes, increased speed and reliable operations.

The answer to the question about a general CIM strategy for the graphic arts industry is that some high-level strategies are possible for companies that are willing to operate in the same way but the paths are probably different. The reasons for this are

- the differences in company strategies and products ( prices, flexibility etc.)
- the differences in the present state ( age, level and rate of the current systems)

One very important thing from the company's point of view is that in the first stage CIM is not a question of the technique but it relates to the ways of procedure for the company to survive in the future. Once an answer is found to this last question, suitable measures can be chosen.

At the processing level pre-press and design are already integrated to some extent and this development is continued. The control of press and post-press processes should be more efficient and the automation level higher. Integration is needed for control and feedback information. Automation of the material flows is needed for the physical integration of different functions.

The most important aspects from the company's point of view are

- efficient functioning with customers, subsuppliers, raw material suppliers
- efficient functioning inside the company
- basics (quality, logistics) have to be in order before CIM

The most important aspects for research are

- principals for planning and controlling the production
- information management

## Future development

As mentioned above, one of the areas for further development is production planning (= product design+how to manufacture+when to manufacture). A large research program, *Product Models for Product Design and Production Planning*, was launched at VTT earlier this year. Of the three subprojects, one concentrates on the graphic arts industry. Our aim is to develop new tools to increase the efficiency of production planning and control, and to integrate them with product design. These studies are based on modelling of products and processes. This is a new - and by no means easy - approach. Knowledge-based engineering and object-oriented programming will play an important role in practical applications. Our other activities in the field of the knowledge-based solutions for the graphic arts industry are reported in another paper at this conference.

Another area of research is the automation of materials handling at the printing plants. If the graphic arts industry plans to adopt CIM applications, it is necessary to find solutions for flexible automation of the material flows, flexible capacity, automated quality ascertainment with fast feedback control, and minimization of the presetting times. This relates to nearly all types of production from newspapers to books. Traditionally, we develop quality automation especially for printing presses. Now we plan to broaden our scope and to combine quality ascertainment at the production level and at the operational level.

## Conclusions

The special character and the wide product range of the graphic arts industry makes it difficult to apply CIM without analysing the business structure of the company. It is necessary to make an understandable model for the systematically aimed target stage. It is usually not possible to change the entire production environment and to take brandnew equipment into use. The only way is to proceed step by step. The development of computer technology is towards open systems which should give more freedom to integrate different systems. The companies should, however, acquire more knowledge and the skills to plan their future in order to take advantage of this. This is one reason why we have begun to study the application of CIM in the graphic arts industry. A number of common problem areas have been found and research will be focused on these fields. We also seek international cooperation in this field, because the problems are by no means national.

## Literature

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## APPENDIX 1.

### SADT-Structured Analysis and Design Technique, SADT

The SADT is a design technique published by SofTech in 1977 ( Ross 1977, 1985, Ross & Schoman 1977 ). The method is quite generic and can be applied to the analysis of different kinds of problems. The SADT includes a graphical description language and a set of design principles. The descriptions are hierarchic data flow diagrams. Material flows can also be modelled. The basic idea of this technique is to present an easily understood amount of information at a time. The functions are marked by rectangles in which the four edges describe the input, control, output and mechanism used, Fig. 1. The SADT bears a close resemblance to Data Flow Diagramming ( DFD ) but allows slightly more freedom in modelling.

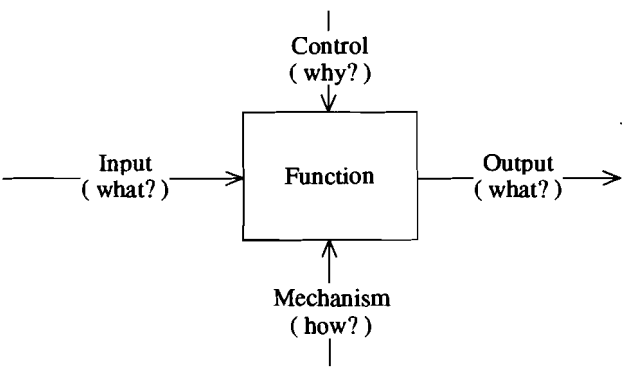


Fig. 1. The basic elements of the SADT ( Ross 1985 ).

The mechanism is a reference to another model, machine, human being or department that is used in operating the function. The arrows represent the flows - both data and material. A simple logic can be found although the model does not describe the actual dynamics and logical behaviour of the system, i.e. the time perspective is not considered. There are also extensions to the syntax for this purpose.

The SADT philosophy also contains instructions for interviews, walkthoughs and project management. The method itself offers many freedoms of use, requiring only a certain amount of common sense of its user. The SADT has been applied to the analysis of the systems to be constructed and to already existing systems. Among the possible modelling targets are, for example, software requirements analysis, user interface design, modelling of production activities together with information and material flows, etc. The technique is efficient in the early phases of system analysis but not especially applicable in software design. The SADT has also contributed to the development of other modelling languages. For example the functional level of the IDEF (Integrated Computer Aided Manufacturing Definition Method), i.e. IDEF0, is based on the SADT.