

AUTOMATION in practice

EVOLUTION OF COMPUTER INTEGRATED MANUFACTURING IN FLANDERS 1985-1995 — A DELPHI SURVEY

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1. INTRODUCTION

The developments in the field of micro-electronics have caused an accelerated renewal of process technology in manufacturing companies, which will undoubtedly thoroughly change the shop floor. With the aid of the computer there are attractive opportunities to increase the productivity and flexibility of such diverse tasks as design, job preparation, production planning and control, maintenance, testing, logistic management. But the integration of these tasks in order to obtain the "Computer integrated manufacturing" system could cause additional important increase in productivity, flexibility and logistic management. The building blocks of these CIM systems can already be found in our own companies at this very moment in time.

The integration towards the complete system is hampered by a number of technical, organizational, social and political problems. A number of priorities have to be pinpointed without losing the view on the total picture. This survey was intended to assist key decision makers of our companies and related governmental organizations in their planning effort.

Planning is a management process that improves communication regarding future directions and goals. As a result, increased emphasis on strategic planning will allow manufacturing suppliers, CIM manufactures, financial institutions, government and related industries to address the dynamic technological and market changes projected for the 1990s.

Predicting the future, even with the Delphi-method, remains a risky undertaking that leaves only one certainty: that reality will somehow turn out differently. The undertaking is nonetheless very commendable, because the alternative — waiting for the future to come to us — is for most of the people involved not only unattractive but also catastrophic.

The study and the report [1] concerning computer integrated manufacturing in the nineties was a joint effort

of the management consulting division of Arthur Andersen & Co. Brussels and the publishing company Technipress. The project was started in November 1984 and ended in October 1985.

2. METHOD AND APPROACH

This comprehensive forecast was created using Delphi-techniques. Delphi is a systematic, iterative method for forecasting based on independent inputs from a group of experts. Its objective is to obtain a consensus of opinion from the panel of experts regarding future events [2].

In practice, forecasts or estimates of long-term future scenario's may be derived using numerous methods, including intuitive forecasts, trend extra-polation, trend correlation analysis and analogy techniques.

Like other intuitive forecasting processes, such as a poll, committee or panel consensus, the Delphi method relies on the judgment of knowledgeable experts. One of its values is derived from realizing that future projections, on which decisions regarding policy must rely, are strongly influenced by personal preferences and expectations, in addition to more quantitative factors. In this survey, the Delphi process involved polling panelists anonymously on a list of questions.

In total 85 experts in CIM matters were approached of which 60 % agreed to cooperate. Percentagewise the experts consisted of constructors of CIM (24 %), users of CIM (50 %), academic staff (18 %) and consultants (8 %). Within the group of user experts 72 % came from companies earning over a 20 million \$ turnover and 60 % worked in companies with more than a 1000 employees. On the part of the CIM constructors 17 % of the experts were members of companies earning over a 20 million \$ turnover, 33 % had a turnover between 2 and 3 million \$ while 50 % of them worked for companies with less than 100 employees.

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The type of production process they were involved in indicated for the user-experts : 37% in serial manufacturing, 32% in project-type manufacturing, 18% in mass-production and 18% in continued-process production. For the constructor-experts these figures were; 42% in the project-type manufacturing, 25% in serial type, 33% in mass-production and 33% in the continued process-production.

3. RESULTS OF THE DELPHI-STUDY

The domain of CIM technology in Flanders for the next 10 years was split up in seven topics which may influence or be influenced by future evolutions. The topics were :

- Current use of CIM
- Expected impact on industry
- Expected impact on industrial relations
- Governmental actions
- Evolutions in foreign countries
- Impact on management
- Strategies for CIM introduction into business.

3.1. Current use of CIM

The most widespread applications within CIM is Computer Aided Design and Manufacturing (CAD-CAM). At the moment 50% of the experts working in industry claimed they had already applied CAD-CAM software. Another 30% of them expected CAD-CAM to be introduced within the next five years. In the field of Computer Aided Testing (CAT) 30% of the experts possess already existing applications while 15% will set up CAT systems by 1990. The least propagated applications (only 20%) are situated in the field of Computer Aided Logistics (CAL) and especially Vehicle Scheduling. The experts believe that the biggest relative growth within the coming five years will be situated in CAL and more specifically manufacturing resources planning (MRP) and distribution automation. They expect the number of CAL systems ten years from now to equate the number of currently installed CAD systems. A majority of the experts (60%) are of the opinion that the two reasons behind the current installation of CIM technology are improvements in productivity and flexibility in the production process. High labor wages and quality improvement contribute to further automation. 65% of the experts consider these last two factors to be changing from very important to important but not principal. The main advantages in the use of CIM technology cited by the experts include a decrease in the production lead time and the quality of the end-product, a decrease in inventory and the cost of the end-product and also better delivery-terms and productivity. By 1995 the most important advantage of CIM in the opinion of the experts (68%) will be productivity improvement. For more than 80% they agree that production flexibility, better quality and improved control over the production process will aid further installation of CIM. However, the experts consider the productivity of dis-

tribution lagging behind as a serious problem. The root of this is the current state of CIM technology, being such that the majority of applications are situated in the field of CAD/CAM. Building up productivity in the distribution-net requires the introduction of CAL systems, which would explain the expected growth in this area. Another major problem, as seen by 85% of the experts, are the very high investment costs, considered to be the principal obstacle for the breakthrough of CIM technology. Other important counter-effects are the need for thorough support by CIM suppliers and questions marks concerning the return on CIM investments. On the other hand, lack of qualified personnel, opposition from the labor force or the expectation of improved CIM technology are not likely to cause serious obstructions.

3.2. Expected impact on industry

For the next five years to come (1985-1990) the experts expect a considerable growth in the number of businesses in the services industry. This could be a logical consequence of the need for specialized advice many companies will be seeking when introducing the new CIM technology. Another consequence is the increase in the number of manufacturers of measurement, analysis and control instruments, the heart of many CIM applications (11% growth). The same can be said of the electronic and electric machine and component industry (6% growth). According to the experts, the victims of this evolution will be found in the furniture and non-electrical machines industries. The furniture industry will know an expected decline of more than 8% due to the heavy investment burden causing loss of competitiveness. The non-electrical machine manufacturers will have to look desperately for new applications in the light of increasing automation. The sectors in industry which act as users rather than as suppliers of CIM technology or related know-how, will probably evolve in the same line as the furniture industry but to a less extent. The experts estimate the general evolution in "press and publishing" (-3%), the petroleum sector (-2%), the food industry (-10%), car assembly industry (-19%) and the tobacco industry (1%).

In the long run (1990-1995) the experts predict an increase in the number of companies in the sectors which have been previously "thinned out" during the period 1985-1990, e.g. car-assembly, tobacco and chemical industry. Other business will only then start reaping the fruits of the investments made in the second half of the eighties e.g. the textile sector.

The reason for these shifts in the total number of companies involved, mainly has to do with increasing productivity and flexibility and the fierce competition as a result of these two factors. The study points out that not only the total number of companies involved will change but also the size of these companies. Medium sized companies (+ 1000 employees) will be worst off while large companies will know a slight increase in number. The biggest increase however is to be expected with the smaller companies (- 100 employees); the experts

predict an 11,5% growth within this category. In general, the impact on industry of CIM will be further characterized by an increase in user-friendliness (70% of the experts) and a decline in the cost of CIM components (60%). The effort to integrate the different components making up the CIM systems will be intensified, perhaps using some form of higher intelligence (57% of the experts).

3.3. Industrial realisations

The experts anticipate a sharp decrease in direct labor (-7%) in the period 1985-1990. During the same period there would be a noticeable increase in R&D personnel (+7%). There would be a striking global personnel reduction and an increase of R&D staff trying to make-up for the loss of employment. From 1990 to 1995 the anticipated decrease could even be higher and reach 11%, while the experts predict a continuing increase in R&D staff with 8% after 1990.

The overall trend in industrial relations would be one of higher education and training. More than 90% of the experts feel that future managers of companies using CIM will be university graduates who will need permanent training. At least 70% of the experts is of the opinion that a couple of years in high-school will be a minimum for future workers, in a CIM-using company. Administrative personnel should be graduated from high school, while production controllers should have a university degree or some additional training. People in staff functions would need facilities for permanent schooling, especially R&D personnel. The experts also think that the CIM technology will increase job motivation of R&D personnel, production controllers and management, by reducing routine work and calling for more "intelligent" work. Lack of necessary qualifications or fear for loss of jobs could have a negative effect on the motivation of direct labourers and administrative personnel (according to 60% of the experts).

3.4. Governmental actions

There is a certain unanimity among the experts concerning the need for the government to first of all adapt the current education programme and elaborate in parallel the existing professional training programmes. 80% of them called for a closer collaboration between industry and the educational system. They anticipate a serious lack not only of means to provide a sound and up-to-date education, but also of qualified teaching staff in CIM-related matters.

In the next 10 years experts anticipate that governmental intervention will mainly consist of financing research projects and taking financial participation in new enterprises. Promotion activities in foreign countries and stimulating joint ventures are other areas for governmental actions. However, the experts are convinced that the most efficient strategy would be to take certain fiscal measures in order to promote CIM technology, in combination with the strategies already discussed.

More than 50% of the experts involved do not think that CIM technology would be stimulated by exerting pressure on employers' or employees' organisations.

3.5. Evolutions in foreign countries

82% of the experts expect an almost certain increase in international competition due to introduction of CIM technologies. In foreign companies over half of them consider it to be very probable that CIM applications in foreign countries will lead to a higher penetration of foreign products on the Belgian market, stepping up competition.

3.6. Impact on management

An increase of 18% in quality improvement is expected for 1985-1990, going up to as much as 22% for 1990-1995. As a consequence of CIM applications, production capacity could grow 10% over the period 1985-1990. During the 1990-1995 period another 18% growth could be realized. Delivery times could be decreased with 12%, mainly from 1990 onwards. For the ten years ahead, the experts do not anticipate a significant reduction in cost amounts.

It is expected that the planning horizon will be shortened considerably. 88% expect the planning cycle to be shortened by over 30%, more than half of them think it is possible to halve the planning cycle, a third of them expect a reduction between 20 à 30%.

On the other hand the importance of planning ahead will gain in weight (80% of the experts). In the opinion of 90% of the experts, CIM applications allow a better evaluation of planning alternatives. Also the mix of personnel responsible for planning will undergo a significant change.

The reasons behind the increasing concern for planning are :

1. the breakthrough of the just in time philosophy which requires better planning;
2. CIM only pays when there's a good planning; interruptions can have serious consequences;
3. short delivery terms can only be accomplished and used if accurate information is available.

So the experts forecast that production, marketing, R&D, engineering, purchasing and quality control will all be very closely involved in the planning process.

The experts think that production-related departments will become more important as CIM technologies are introduced. On top of the list of priority departments are manufacturing and those departments which have a direct impact on the success of CIM implementation : R&D, engineering and EDP. Last on the list are the support departments such as maintenance and quality control, inherent to the optimal operations of CIM technology.

The future manager in CIM companies will need a technological and production-oriented training combined with a broad versatility and a commercial mind. He should not be preoccupied with costing, because this

aspect of production will be resolved by the CIM technology itself, optimizing the production process for a given product (type) and a given time horizon. In this context selling what has been produced, is the main concern.

3.7. Strategies for the introduction of CIM technology

The experts agree on the success of top management involvement in the introduction of CIM technology. In addition, qualified personnel should be available, and some external assistance where needed. General attitude and motivation of personnel and a project approach towards the introduction are also key issues.

In setting priorities, the experts believe that first CAD/CAM systems should be introduced which could be fully integrated by 1989 in most companies. A second priority is given to the integration of computer aided manufacturing (CAM) and manufacturing resources planning (MRP), which should be commercially available by 1990. One year later CAM/CAT integration can be expected to be commercially attainable. Although the priority of the integration of CAL/MRP is set lowest by the experts, these systems could already be commercialized by 1989.

The first reason for the CAD/CAM system to be developed first is that this eliminates a lot of expensive and useless steps in the design and introduction of systems that allow that kind of integration. A second reason is the tendency towards speeding up product development due to the shortened product life cycle. This calls for a production technology that allows small series but wide diversification, in other words : flexible products. As a consequence, CAD/CAM-systems are commercially very interesting in the short run.

The integration of CAM and MRP needs to be realized through a data base with the right DB-technology. The availability of software for DB-handling, CAM and MRP should result in the integration of these components. The desired integration between CAM/CAT is one that results from necessity. Higher production capacity and flexibility call for a system that can guarantee the quality of the product.

Integrating CAL and MRP could be realized quite soon although according to the priorities set there's no immediate need. Once CAL will be fully installed the integration of MRP will be relatively easier.

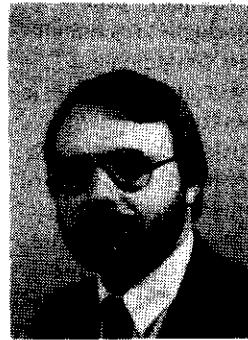
The CIM concept of full integration as presently defined cannot be expected earlier than 1995. In the opinion of the experts CIM will probably never be commercially available as a standard package; the necessary technology will be on hand, but it will be up to the company itself to implement it.

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