Interaction Between Technical and Organizational Features of Computer Integrated Manufacturing

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SUMMARY  The interaction between technical and organizational features of technology is often not given sufficient attention during the consideration of new manufacturing techniques. To maintain the system's operation, Computer Integrated Manufacturing Systems require employees with both new technical skills and an ability to share information and to coordinate their efforts. The ability of personnel to rapidly respond to the demands of a system with complex cause-effect relationships, is dependent upon appropriate organizational mechanisms. As the efficacy of such mechanisms is subject to shopfloor acceptance of wider responsibility, shopfloor personnel and their representatives should be involved with their formation.

1 INTRODUCTION

Management is attracted to Computer Integrated Manufacturing Systems (CIMS) in the renewed hope of finding the technological means of conquering the ever illusive objective of a completely rationalized, and rational, total-factory environment, which reacts quickly and predictably in response to managerial directives. Automation is progressing towards systems in which, in the words of leading CIMS consultants, Thompson and Scalpone of A. T. Kearney Inc. of USA - "The computer links processes together, ties product design to manufacturing and integrates business planning and control systems into a total operation" (Thompson).

In many cases, companies may experience a quite different reality. Difficulties with implementing CIMS (and for that matter FMS and CNC) include unforeseen programming costs, greater than expected frequency of equipment breakdowns, unexpected materials wastage and spoilage, workpiece misalignment, the disruption of informal communication networks on the shopfloor and resultant loss of opportunities for learning on-the-job of critically needed skills for maintenance, for supervision of automated processes, and for experimental development of new products and processes.

When choosing new manufacturing systems, managers can easily suffer misconceptions about the relative importance of different cost factors as well exhibit a tendency to overestimate the net benefits expected from the new technology and to underestimate their dependence on skilled workers' practical knowledge about the production process. There is a general disinclination for managers to discuss their own production plans with managers from other companies in a serious and indepth manner (displaying not only the successes, but the problems and failures as well). This lack of openness cuts them off from an important source of experience.

Also, fearing disruption, they are generally unwilling to negotiate with unions over plans to introduce new technology. But the consequence of not providing unions with an avenue to participate in decisions which may affect their members may be worse. They may respond with resistance of either an active or passive nature. Passive resistance can be very potent in CIMS where shopfloor intervention is vital for maintenance of the system's performance.

2 THE WORK PROCESS AND AUTOMATION

Before focussing on the specific effects of CIMS, the general effects on the human well-being derived from the preceding pattern of automation need to be discussed.

With the progression in the application of automating techniques, the role of the production worker has tended to shift towards the monitoring of the systems. While the shopfloor worker must have sufficient knowledge to maintain performance of the system, there is a move towards a general deskilling, through a reduction in knowledge of the process as a whole. There is a trend towards polarisation of skill levels. For example, the programming of robots and computer-based tools may not be performed by those who operate them. While the range of trade skills has tended to diminish, the demand for employees with professional engineering and computer programming skills has increased.

With the move towards more highly capital-intensive machinery, there has been a quickening in the pace of work. This can be seen in the case of NC machine tools, where more operations are concentrated on one machine. The throughput time of each batch is therefore reduced which forces tightening in the scheduling of the work. ASTEC reported that accompanying automation was a quickening of response to the diagnosis of a problem and corrective action. This aspect of automation is quite observable in the work associated with continuous casting of steel, where "...much time is spent watching dials without taking action, but precise and quick evaluation and action are expected if a malfunction occurs, in order to prevent disturbance of the workflow in an integrated plant with fine tolerances in timing". (sec 7.14).

Because of these demands, companies introducing
computer-aided manufacturing will embark on restructuring their production management systems, from being based on the coordination of human activities to becoming centred on the functioning of a complex inanimate-system.

3 CHANGES TO THE WORKING ENVIRONMENT

Successfully implementation of CIMS requires a basic change to the operational environment, and thus the working environment. Thompson expressed this need in his discussion of Flexible Manufacturing Systems:

To accomplish this integration requires an information intensive environment, where process knowledge is stored on software rather than in people or bits of paper. The computer demands and uses huge amounts of information to make routine decisions and to control the manufacturing process. This simple fact has a dramatic effect on the people who work in the FMS environment... (ii) their role is no longer making a product so much as it is the care and feeding of the highly complex system.

The organisation of work processes based on the principles of Scientific Management (job specialization, hierarchy of jobs based on skill content, incentive pay) are inappropriate when it comes to CIMS. With CIMS, as a consequence of highly complex cause-effect relationships, there is much difficulty in the maintenance of the system's performance and the product quality. Thus, the tracing of quality problems requires time consuming detective work. This becomes quite difficult when there are few human operators with whom to liaise. This problem is further exacerbated by the disruption of the traditional avenues for obtaining skills on the job; through the formal apprenticeship system and the informal communication networks on the shopfloor. Thus, an important developmental path for generating critically needed skills for maintenance, for supervision and for the research and development of new products and processes is severed.

4 WORKER INTERVENTION

While this process of rationalisation is desired by management, the reality is that the sheer complexity of the system places a counterpoising need for maintenance of the system to be undertaken by highly skilled people.

Because the functional components of these highly integrated systems have complex interactions, 60-70% of unplanned maintenance time is spent in problem diagnosis (Thompson). Since such systems consist of a number of different functional components - electrical, mechanical and electronic equipment and computer programs for controlling both individual machines and the total operating environment - in order to locate the source of a problem, extensive communication with production floor people is required. Production operators understand the 'normal' behaviour of the equipment, and they can observe early signs of deteriorating performance. Effective communication between maintenance and the shop floor means less time spent in diagnosis.

The performance of the system becomes reliant upon workers in different jobs exchanging information on a continuing basis. Teamwork becomes the most effective way to respond quickly and effectively. As more responsibility has to be assumed by such teams, participative management becomes desirable from a human relations standpoint.

"A number of recent studies have demonstrated how production workers maintain and improve productivity levels by making strategic interventions in production processes aimed at reducing machine error and waste and preventing breakdowns and bottlenecks. Yet rarely is the option of increasing the opportunities to make such interventions given preference over technological change as a method for improving productivity". (Kelly)

5 TRAINING

What needs to be recognized and emphasized is the fact that the human element is still very essential to advanced manufacturing systems, and for optimal production, workers should be trained with the necessary skills rather than deskillled. The requirements of training are especially important when considering that personnel coming to work on CIMS (or FMS) for the first time need:

(i) Orientation on how these systems differ from traditional production line or transfer lines.

(ii) Training on individual machining centres and operating procedures.

(iii) More advanced training for maintenance people including system logic.

Particularly in small batch production, the limited nature of the production-runs requires quick assessment of whether the system is performing in the most appropriate manner. No longer is it possible to rely on shopfloor personnel realizing that there must be something wrong with the system's performance merely through observing a deviation from normal 'rhythm' of operation. Instead, shopfloor workers will need more advanced training. Such training tends towards systems' orientation and abstraction, as these skills are necessary to reduce expensive diagnostic time.

While there is the need for advanced training, much of the practical trade-based knowledge may be lost, as these technologies have the potential for disrupting opportunities for on-the-job training. Thus, the training that would have taken place informally on the job as a by-product of the production process must be explicitly provided outside the process at additional cost.

For a variety of reasons, planners are failing to give sufficient attention to training matters. The end result is greater time spent in diagnosing problems, and in costly trial-and-error learning on the job. (Thompson)

6 EFFICIENCY THROUGH BROAD CO-OPERATION

The flexibility which computer-based technologies has brought to manufacturing is not merely restricted to the inanimate component of the productive forces. The organization of the work process is not so constrained by technological rigidities as was the case in the past. It becomes an organizational decision whether, for example, programming is undertaken on the shopfloor or in a separate department. If shopfloor
personnel are so trained the organization benefits in higher skill utilisation enhances the overall organizational flexibility.

The sheer complexity of the myriad of tasks required to be performed in CIMS warrants involvement at all levels of the enterprise, including the shopfloor, as the optimisation of all facets of production is extremely difficult to be done at a global level.

Kelly argues that "the prospect of reducing the costs associated with the deployment of programmable automation depends far less on R&D investments than on the establishment of a climate of cooperation between workers, their representatives, ..and management... To fashion workable solutions to implementation problems will require a sharing of decision-making power among workers, unions and managers in ... investment decisions, the organization of production, and the design of jobs".

7 EXTERNAL SOCIAL FORCES LEADING TO WORKFORCE INTERACTION

There has been a move in recent years for the labour movement to seek the instigation of organizational mechanisms which will ensure that the quality of the working environment is at least maintained, and hopefully improved, when new techniques of work are introduced. In doing so, there is a challenge to what is seen by management as its prerogative, that of deciding organizational practices and technological forms. National union policy has gained support through judicial, legislative and contractual agreements as well as national union policy.

7.1 Policy Support

The ACTU 'Policy on New Technology' (1979) states that "trade unions, must, as a right, be included in the planning stage of technological change as a condition precedent to any changed operations". The essence of this policy is that unions should, on the working issues arising from technological change, seek, from the contemplative stages, mechanisms to challenge traditional managerial attitudes and prerogatives regarding consultation, notice and the right of termination.

7.2 Judicial Support

The ACTU was able to obtain some teeth to this policy through the Job Protection Test Case which resulted in the insertion of a number of clauses relating to job security into the Metal Trades Award. The section dealing with technological change requires employers to notify unions six months before any impending technological change, to enable consultation over such issues as redundancies, income maintenance, and retraining. This initiative, along with other legislative attempts and judicial interpretations, is quite narrow. Notification is restricted to the immediate effects on employees. Consultation is thereupon constrained to consideration of measures to avoid or mitigate the adverse effects of such changes.

7.3 Legislative Support

In Australia, legislative support for consultative mechanisms have not generally been instigated. One exception is the 1983 amendment to the Victorian Industrial Relations Act, which empowers the Conciliation and Arbitration Board to make awards in relation to the duties and responsibilities of employers upon the introduction of, or decision to introduce, technological changes.

In the future, much more stringent legislative changes may be sought along the lines of the Swedish Co-determination Law, and the West German Works Council Act. Paragraph 91 of the German Act empowers Works Councils to intervene and demand correction of jobs that have been organized in a way that contradicts tested scientific knowledge with respect to human requirements.

7.4 Contractual Support

With the general interest shown by the Federal Government and the Trade Union movement in Scandinavian Industrial Models, the Norwegian Basic Agreement (1982) may be especially pertinent.

The following is stated in the section on Technical Development and Computer-based Technology:

New solutions and systems may affect the employees' workplace and working conditions. When this is the case, it is important that new technology is not just evaluated on the basis of technological and financial conditions, but also based on social considerations. This overall consideration forms the basis for the design, introduction and use of systems and new technology... Changes in organization, employment, information routines, contact between individuals, etc., shall be included in this general consideration....

For work situations which come under this agreement, the parties shall discuss in advance how the work structure, management and working conditions may best be arranged. Training and retraining needs shall be clarified during such discussions. Development of the professional content of the individual jobs shall be particularly emphasized.

This agreement is not merely one of rhetoric, as organizational arrangements have been formulated to ensure compliance.

8 THE AUSTRALIAN EXPERIENCE

In Australia, consultative arrangements for the design and selection of technology which is to be implemented in the manufacturing industry has a long way to go. A 1979 study by the Department of Science and Technology revealed that even the essential requisite of provision of information associated with proposed technological change is not supplied to the unions. Only 6% of the sample had any formal consultative body to cater for joint decision-making. The issues over which such participative consultation was considered appropriate were few and at a low level, with emphasis on some aspects of workplace design and choice of the particular type of technology. For the majority of cases (66%), management retained its right to decide what information would be supplied. Only 29% of this group gave employees the opportunity to express their views and opinions: though management retained its right to make the final decisions.
9 THE POLITICAL ENVIRONMENT

At the early stages of the decision-making procedures, leading to the implementation of Computer Integrated Manufacturing Systems, there should be due regard for the interaction between the technical and organizational features of the technology.

In making funds available for advanced technology, the Federal Government has put on the agenda such concerns. Its pilot programme for assessing industry's need for assistance with the implementation of Computer Integrated Manufacturing, also includes social and organizational factors as well as the technological and economic factors. Especially stated concerns with the impact on: employee and union attitudes; the occupational health and safety; the recruitment; redeployment; retraining; and the skills mix.

10 CONCLUSION

Under the present political climate where the Federal Government is promoting consultative mechanisms for the trade union movement, a unique opportunity has arisen for unions to seek a more significant role in decision-making associated with the introduction of new manufacturing techniques.

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