CIM/MAP/TOP/UNIX: WHERE IS IT LEADING?

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The Route to CIM

CIM (Computer Integrated Manufacture) is becoming a reality. Most areas of manufacturing can be computerised today and more significant development effort is currently going into linking "islands of automation".

Generally, all that stands between us and the unmanned factory are money, discipline and dedication. The technological problems have largely been resolved. There is no doubt, however, that some areas of CIM are difficult to justify in specific companies and whilst certainly cost of computer hardware goes down, this is not reflected in other hardware, (such as machine tools) and in software.

Furthermore, by its sheer project magnitude, CIM must be a progressive evolutionary process within any one company.

It is therefore important to determine a basic business development strategy which will lead towards CIM in [illegible]rly defined steps in line with corporate objectives, but with the flexibility to adapt that strategy to new technological developments as they occur.

To wait for new developments in the current fast-changing technological climate implies procrastination and loss of opportunities. It is therefore unacceptable if a competitive edge is to be maintained.

We are faced with the need to select and implement one particular functional solution at a time, and integrate it with existing manual and computerised functions to maintain at all times an integrated network of functional business solutions which jointly allow us to manage the business effectively.

Business Functions and their Integration

A business system can be split into a number of sub-systems. These have traditionally been self-contained departments with a sufficiently high level of interfacing to allow the business to achieve its objectives. These interfaces have not always been adequate. Departmental parochialism, political ambitions of functional heads, but, [illegible]ve all, the sheer inefficiency of such interfaces has caused companies to be unable to achieve their objectives and lose their competitiveness in the international marketplace. Streamlining of particular areas by, say the use of localised computer systems has often not improved overall business performance but has indeed at times degraded it.

Any one business needs to focus on two areas:-

i) a business control structure which ensures that all activities in the company support a common game plan

ii) a level of integration which ensures that the current status of the game plans is known to all players at all times.

Figure 1 shows a typical business structure which needs to support (or be supported by) Computer Integrated Manufacture.

The two key activity areas are generally:-

- Business Planning
- Operations Planning and Control

Business Planning is taken here as the "driver" of the business. It provides the supply-demand interface and accumulates the statistics required by the business to understand clearly its relationship to the marketplace in terms of past, current and future sales, and responsiveness to market demands. It also concerns itself with high-level resource planning and provides the data to top management and appropriate service departments to change the volume and mix of available resources. It includes all traditional master production scheduling activities, extended by a range of modelling and statistical analysis tools to provide a forecasting and prediction capability to guide sales and marketing. This function, also referred to at times as "logistics" is potentially the most important and most powerful one in the business. It balances the supply-demand picture for the company to ensure that the business can satisfy a planned level of output within agreed resource constraints, flexibility and variability.

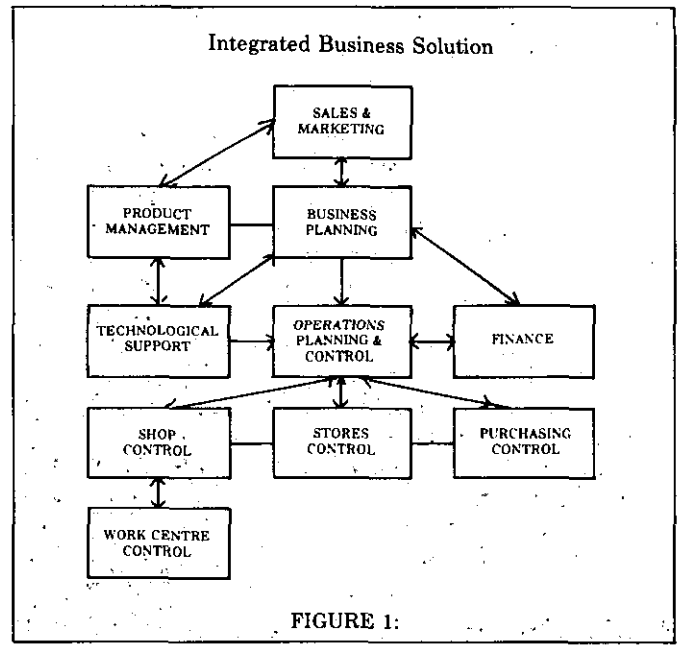

FIGURE 1:

Operations Planning and Control covers traditionally the area dealt with by most modern MRP packages i.e.:-

Supply-demand balance
Inventory control
Order release and monitoring
Shop order tracking
Purchase order tracking
Exception/action reporting and management
Transaction history
- stocks
- orders
- labour performance
- scrap/reject
- machine utilisation

Management control reporting
Shipping and despatch

All other sub-systems surround these two vital planning and control systems. They receive data from them and, if appropriate, feed data back.

Until recently these two major manufacturing planning and control systems were generally centralised on one machine divorced from separate localised solutions for specific technological areas such as DNC and FMS for example other functional areas had their own systems such as CAD/CAE on independent work-stations. Financial and distribution systems ran typically on the same

machine as the main manufacturing business system, but were usually not integrated and at best linked by a periodic batch data transfer.

That situation is still found in many companies, but the picture is slowly changing. Ironically, it has been the smaller companies who have taken the lead and insisted at least on an integrated business system on one machine with real-time and batch links as appropriate between manufacturing, finance and sales order processing.

In larger companies such integration has been much slower. Integration of independently installed systems has been difficult and expensive. Larger users with mainframes have also found that it may be difficult to purchase a range of application packages for one computer and compromises have had to be made. Where independent technical sub-systems were installed, for example by production engineers and designers, connectivity to existing mainframes was often found to be difficult and expensive.

Two main technological trends have emerged to overcome these problems.

i) portability of software across different machine environments, either inherent in the software or by standardising on a common operating environment (where UNIX appears to be the emerging standard, particularly in manufacturing applications)

ii) networking and communications standards such as ISO-OSI, with MAP and TOP protocols to enable different systems on different hardware configurations to communicate without expensive development effort and in a manner which is transparent to the user.

Integration of all business sub-systems is clearly essential to ensure:

i) *the whole* company supports the business plan

ii) data is only entered once and updates all affected databases

iii) the *whole* company works with one common data set.

The latter issue does not necessarily imply the use of one company-wide database. Indeed past experience has shown that a business systems design based on one single database is normally impractical and in any case too inflexible. It does, however require that one transaction updates all affected databases automatically without duplicated manual input. Such update does not necessarily have to occur in real time. The merit of real-time integration versus batch integration depends very much on the particular sub-systems involved and, for that matter, the particular operational demands of the particular business concerned. For example, in many companies the integration between purchasing and inventory control needs to be in real time. The integration between inventory control and the general ledger may well be acceptable as a periodic batch update.

OSI — Communication Standards for Factory and Office Systems

The dramatic growth in the availability and application of computer systems in all areas of business and industry makes it ever more essential for the separate elements of such systems to be able to communicate effectively. The phrase "Islands of Automation" has been coined to describe the situation that is occuring where different systems exist in splendid isolation and any communication between them is at best difficult, at worst, non-existent. Companies such as General Motors, are beginning to recognise that the efficient use of systems and data is the next major crusade to be undertaken in the drive for ever lower costs and increased profits.

With the wide range of manufacturers, all producing equipment to address different aspects of business/industry automation, it is most unlikely that any one supplier can produce all the equipment required by any one business. Therefore the users are demanding standardised communication between different pieces of equipment so that they can "mix and match" from different suppliers. Thus they can truly meet their business needs, without compromising because they are unable to connect the right equipment.

Internationally agreed communication standards are clearly the key to success.

There are several organisations throughout the world concerned with standards e.g. ISO, CCITT, ECMA etc. Development of a true international standard fully ratified in all aspects is a long, perhaps endless process. As such the practice is often for implementation of a standard to be taken as a "snapshot" of the standard at some partial stage in its development.

In data communications the International Standards Organisation (ISO) have developed a reference model for Open Systems Interconnection (OSI). This is a seven layer model defined as:

1. Physical — attachment to communication lines
2. Datalink — transfer and control of data over communication lines
3. Network — destination switching, routing and relaying functions
4. Transport — user to user services including multiplexing
5. Session — controls dialogues between users and supports synchronisation of their activities
6. Presentation — defines the representation of data, resolving differences between systems
7. Application — interfaces to user applications and gives common services e.g. file transfer.

Specific implementations of the OSI model are MAP (Manufacturing Automation Protocol) and TOP (Technical and Office Protocols) directed respectively at factory floor and office/technical systems. Differences between the two protocols reflect the target use. Thus MAP is designed for high volume and high frequency message passing where very quick transmission is essential e.g. in machine tool control. TOP on the other hand is more concerned with lower frequency messages which individually tend to be large, but where less strict delivery time requirements may apply e.g. electronic mail.

Networking in MAP is defined in terms of Token Bus Broadband systems, while TOP is CSMA/CD Baseband i.e. Ethernet.

Both protocols have options within them and there is also the danger of individual manufacturers interpreting the protocols differently. Therefore there is no guarantee of inter-connectivity of devices even though they all notionally comply with the protocols. One way of reducing such problems is by conformance testing carried out by independent third parties. This in turn complicates matters in that the product may require extra features to allow the conformance test to be carried out.

MAP and TOP are both evolutionary, thus Level 2.1 is currently barely stable while level 3.0 is close to definition.

Major suppliers such as IBM, DEC and NCR are all working very hard to demonstrate their commitment and leadership in the implementation of MAP/TOP within their product range.

Opportunities in OSI developments are clearly very wide. The practical reality of being able to interconnect a wide variety of different applications will radically enhance the capability of businesses to gain real benefits in efficient data handling. Above all the process will become invisible and thus insignificant, leaving businesses to concentrate on their real objectives and eliminating overheads and delays incurred in getting A to talk to B.

Specific short term developments are clearly in the links between CAD, CAPP and CAPM systems and further between those systems and the shop floor e.g. for process control/machine control/scheduling and for data collection from labour and equipment.

OSI implementations under MAP/TOP are not magic answers and their development will be evolutionary, not instantaneous. However, now that major users are defining strategies and insisting on the standards being applied by manufacturers of equipment, then it is likely that the momentum will build up to make the true open system a very real entity.

Software Portability

Understandably every computer manufacturer wants to lock his existing customers into his own technical environment. However, for all suppliers excepting possibly IBM that has also tended to act as a sales deterrent.

Thus a standard operating system such as UNIX has been attractive for many suppliers and customers alike. For example, General Motors has decreed that they will not in future buy manufacturing systems unless the equipment runs Unix V or equivalent. The X/OPEN group of suppliers, including big-name companies such as ICL, HP, Philips, Olivetti etc. have taken Unix as their vehicle for software portability. That level of portability is now emerging and will make buyers of systems largely independent in their choice of business systems. Such a situation where users can mix and match hardware and software as required will allow them to select the optimum business solution without irrelevant technical constraints.

To reach this stage a number of pre-requisites have had to be fulfilled. Unix used to be traditionally limited in its capability to support business transaction processing within a demanding, multi-user environment. Facilities which mainframe users take for granted were generally missing; full screen transaction processing, record locking, full transaction logging and recovery facilities were often not available on Unix machines. Root Business Systems, for example, has written a transaction processing harness for Unix to envelope the Hoskyns MAS range of business application software packages with the level of technical sophistication and security, which Hoskyns' mainframe users would take for granted. Many smaller Unix-based systems did not initially offer these facilities, and any user who has had to re-key a day's or even week's worth of old transactions because of a disc crash or other database disaster would vouch for the need for such facilities.

With the emergence of these systems features, Unix is now becoming increasingly attractive to the larger systems users. Mainframe machine power on an Amdahl or Sequent machine under Unix is now a reality, as is the ability to connect a large number of terminals either onto one large processor or a user-transparent network of multiple machines.

The Way Ahead

There is in the authors' view little doubt that the future lies with small powerful mini and micro computers each one providing a functional or departmental solution for a clearly defined business area, with all machines linked by a suitable network. Only in that way can users be made accountable for their function and their data, and only in that way can systems be built progressively and modified as required to keep pace with changing business needs and technological developments.

A strategic business plan is essential to ensure that a cohesive plan is followed, moving towards an integrated, automated business solution. Like all strategic plans, it will be subject to frequent changes and revisions, but the goal must be clear from the outset to ensure that the correct building blocks are implemented in the required operational sequence.

That sequence may well differ from company to company and is governed by overall business objectives and current strengths and weaknesses.

The objectives in the implementation of a CIM strategy must always be:-

i) flexibility
   - — modularity
   - — software portability

ii) connectivity
   - — use of long-term supported international communications protocols

iii) integration
   - — single point data entry
   - — common data access

iv) cost effectiveness

It is quite apparent that sufficient of future trends can be determined at present, for users to set out their strategies for integrated business solutions *now*. The strategic framework must be in place across the entire business in order to define the form of all future systems. The classic head-in-the-sand mentality is not the mark of winners. Computer Integrated Manufacture will be increasingly important for commercial survival. There is however, a great deal of concentrated planning required to define the integrated business system for any business!