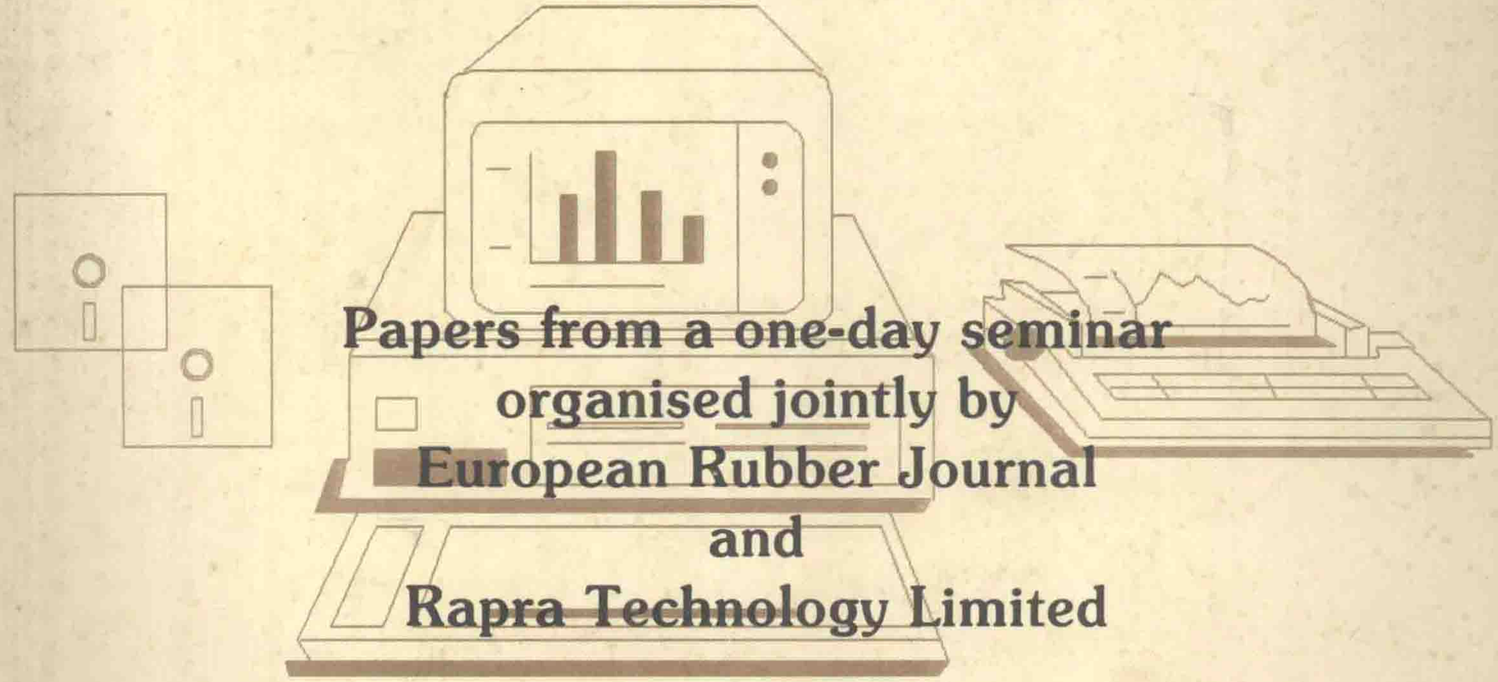
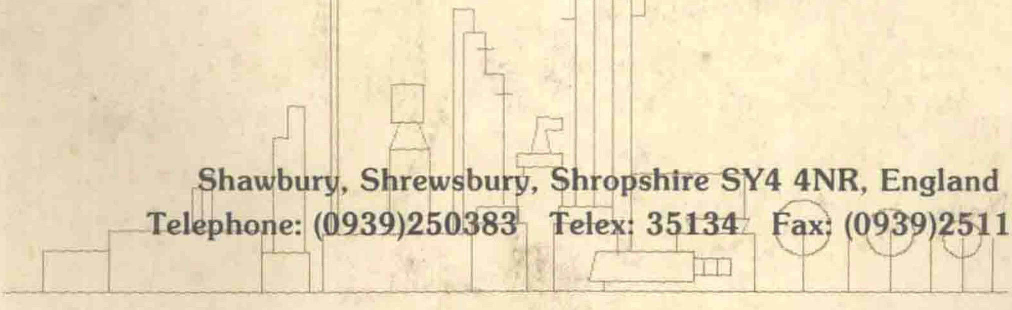
COMPUTERS IN THE RUBBER INDUSTRY



Papers from a one-day seminar
organised jointly by
European Rubber Journal
and
Rapra Technology Limited

4th June 1990



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RAPRA
TECHNOLOGY LTD.

INTRODUCTION

There are few areas within rubber product manufacture where computers have not made a major impact over the last few years. Until recently rubber compounders and processors had lagged behind their counterparts in the plastics industry in their enthusiasm for this new technology. Now, in contrast, the rubber industry is reacting more positively and is beginning to see the benefits possible in product quality and in productivity improvements.

Whether it is the increasingly sophisticated PC on the engineer's desk, the process control units in an ever wider selection of machinery, or the mainframe handling stock and inventory control, computers are becoming an essential part of every rubber business. This trend seems certain to accelerate in the 1990's, as the growing competitive pressures oblige companies to take all steps to improve efficiency.

The role of computers in the various stages of product manufacture will be reviewed during this seminar. Following an introduction by a representative of IBM, the day will include presentations on specific applications in mixing, injection moulding and extrusion. More general uses in materials selection and formulation, and in production management will also be described.

Customers are currently pressurising rubber product manufacturers to supply more consistent goods in shorter time scales. The papers today will demonstrate how computers can help suppliers meet these demands.

As ever, the organisers are happy to place on record their grateful thanks to all the speakers for the time and effort they have devoted to their presentations. We feel confident that their contributions will be of value to all those manufacturers looking to the efficiency and competitiveness of their businesses.

Peter Dickin
Kay Royle
Rapra Technology Ltd.

Babse Holmes
Paul Mitchell
European Rubber Journal

CONTENTS

Introduction – Computers in Industry

Charles Goody

IBM (UK) Ltd.

Mr. Goody addresses the topic 'Computers in Industry' by considering the following:

- The characteristics and uses of computing in the previous three decades.
- The needs and challenges of Industry (and particularly Process Industry)
- The two prime means by which Information Technology can be used in supporting industry:
  - Improving business effectiveness
  - The enabling of business/competitive advantage
- The critical success factors that the Chief Executive should observe in order to make best use of his IT investment.

HISTORY AND TRENDS

Data Processing came into widespread use in larger companies in the 1960s with the increasing availability of low cost transistors and the greater use of disk drives to supplement magnetic tape, which had previously been the only (and very limited) means of storing data.

It is worth recalling that a great deal of work had been done in computing in the 1950s. This had been done almost universally with valve technology which was slow, generated significant heat, bulky and most significantly, very unreliable. On the software side comparatively little progress had been made; computer staffs generally needed a very scientific background and jobstreams and package programs were still a concept being developed.

As mentioned earlier the availability of transistors in the 60s made computers cheaper, more reliable and much smaller. But of equal importance was the improvement in software tools. In the field of computer languages the availability of Fortran, Cobol, PL/1 and RPG made it possible for intelligent (but possibly less than graduate staff) to be used effectively. The development of Operating Systems made it possible for computers to perform strings of tasks with only limited operator intervention and lastly the development of disk storage allowed quite large volumes of data to be held, and also to be accessed quickly.

Thus the 1960's saw the significant change in which computers ceased to be a tool of the backroom but became the common method of performing business tasks.

By the 1970's the foundations had been laid for data processing to increase penetration of the business environment in a very significant manner. Probably the biggest change was that in cost and power. By the end of this decade computers were to be found in the great majority of companies; they were deemed to be an essential part of the business process but they were still almost wholly the preserve either of the computer professional or of the computer literate scientist or engineer usually working in an isolated environment.

Thus the scene was set for the 1980's which could well be entitled 'The Decade of the User'. The most visible evidence of this was the PC; the Personal Computer which through its low cost and user-friendliness enabled an entirely new breed of person to be computer users. These were typically the business professionals and managers who knew a lot about business but knew little and cared less about the developing of systems for mainframe computers. Whereas previously a computer terminal on ones desk was treated with awe it now became the hallmark of someone who was really on top of his job.

It is, however, important not to separate the PC from its mainframe. The really successful user organisations harnessed the user-acceptability of the PC to the Business Strategy attributes of mainframe computers to provide accurate, timely, and absolutely current information to the user, wherever he was within the organisation. Thus the concepts of Computer Integrated Manufacturing became a commercial reality for the first time and Networking of the various parts of an organisation an everyday phenomena. Within IBM there are in excess of 200,000 users linked to each other via a network of mainframe computers in every country in which IBM operates; it is immediately clear that there are significant advantages in being able to send a message to every person in IBM with (say) an interest in the Rubber Industry – but this advantage is much enhanced when one realises that 50% of these are on the other side of the world and cannot easily be contacted by telephone in normal working hours. Various studies have been made which show the benefits of having installed such a system but the clearest benefit is manifested when one realises that no-one could envisage returning to the methodology of memos, letters, telexes and phone calls of just six years ago.

In speaking to an audience of the technical capability such as this, one must also mention the great benefit brought by the sheer power of the PC and of the similar Technical Work Stations.

The rapid take-off of these saw the birth of many thousands of software houses developing an infinite variety of applications of software; the sheer scale of numbers of programs produced for production, design, simulation, numerical analysis and other applications is truly amazing. These also have changed the industry in a way that would have been difficult to imagine just 10 years ago; the agenda of this seminar emphasises the rapidly expanding growth of these methodologies. And so to the 1990's.

BUSINESS INTEGRATION THROUGH TECHNOLOGY

This Reach versus Range chart gives a new way of thinking about the usage of IT both in the past and on into the future.

In discussing the evolution of IT one can observe how the usage of computing was initially confined to the Computing Dept. and some discrete application areas, either in the Commercial or Technical aspects of the business. Through the years this became extended across countries and now, in many companies, to worldwide networks all accessing the same systems and the same data.

One can now see clearly that the concept of the Extended Enterprise is available to users. The Motor Industry was one of the first to make use of the EDI concept across the industry and upwards and downwards to embrace both the suppliers to the industry and the retailers, whether they be selling vehicles, components or replacement items. A concept which those of you working with the Motor Industry will be very familiar.

This then is the environment in which we all operate and to which I will address the main section of this talk.

PROCESS INDUSTRY – TODAYS CHALLENGE

Few members of this audience will fail to identify with one or more of the challenges shown here. The Business Environment in which we all operate is more demanding than it has ever been. Not only are all our customers concerned with quality design, delivery promptness and cost but we all know that they are being courted by other

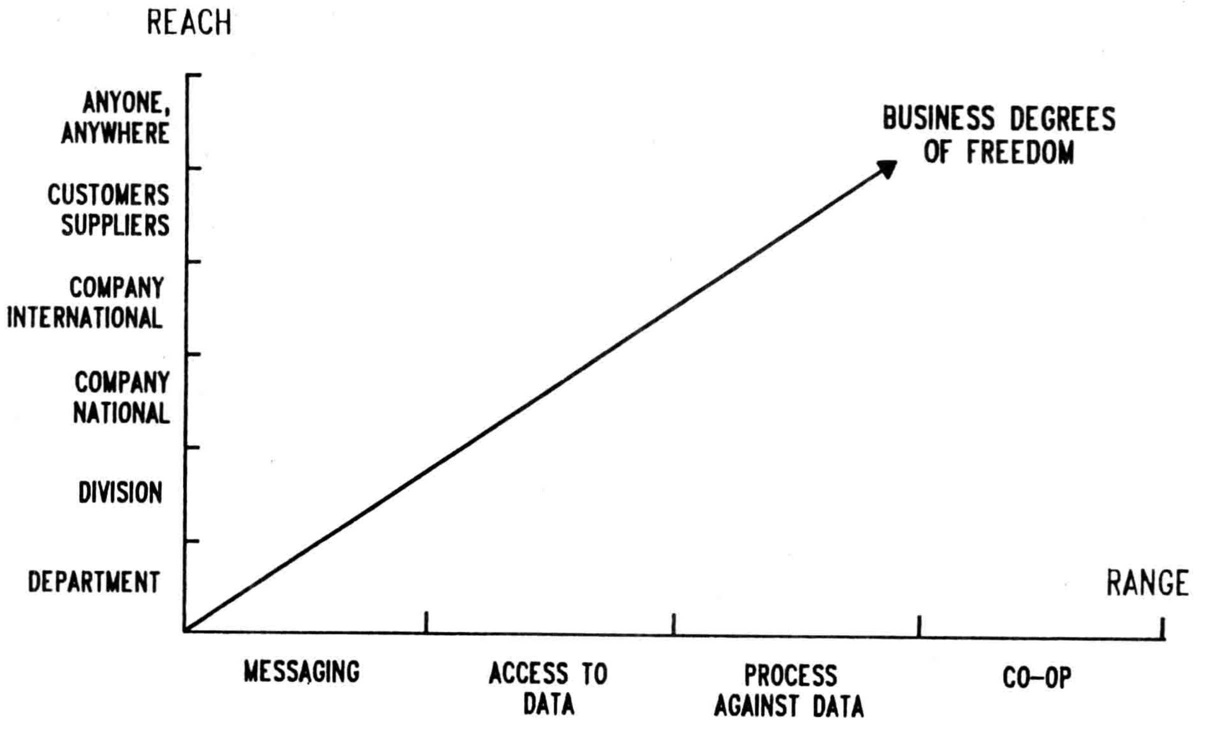

Figure 1 Business Integration through Technology Integration

suppliers who are most keen to demonstrate their capability in these areas; many of these competitors being based outside ones own country.

It is hard, but it's the environment in which we live – 1992 will be the start of an era of rich pickings for those who can demonstrate success; and success will depend on the best use of ones assets; and a truly vital asset is information.

Essentially, for those who currently use IT in an effective manner, there are two main avenues to be explored:

- The improvement of existing business/technical system
- The enabling of sustained Business/Competitive Advantage for your company

These are the two areas on which I will now dwell.

- INCREASE EFFICIENCY
- REDUCE DELIVERY TIME
- REDUCE WASTAGE
- IMPROVE CONSISTENCY AND QUALITY
- FASTER RESPONSE TO MARKET PLACE – FLEXIBILITY
- GREATER CONTROL – INFORMATION

OBJECTIVE – CREATE AN IT FACILITY THAT IS UNIQUE AND PROVIDES SUSTAINABLE COMPETITIVE ADVANTAGE

Figure 2 Process Industry – Today's Challenge

IMPROVING BUSINESS EFFICIENCY

The low cost and ease of use of current IT systems; whether they be mainframes, minis or PCs has meant that the main business needs of most companies are handled competently by these systems. Usually this is in a individual manner such that there is only a small amount of linkage between one system and another.

However, most businesses are aware that there are benefits to be gained from linking the information used by and developed within the main business system. It is linking, or integrating, of such systems that forms the basis of CIM. It is this area which, we believe, provides the greatest opportunity for benefit from the first of the two avenues mentioned earlier.

Islands of Automation

This chart illustrates the manner in which business problems have been tackled, and usually tackled successfully. Solutions have been developed and implemented in each business area, for instance while it is true that output from the Design Dept. is used by the Production Engineering Dept. and it is also quite possible that both depts. are using computer systems, often on the same computer; the data linkage between the departments is usually in a 'separated' manner. I will be addressing the benefits to be obtained in integrating the information of all depts. and will address briefly the manner of doing this. I should add that there are good reasons why no two companies will do this in precisely the same manner so my coverage of this topic must necessarily be broad-brush rather than truly specific.

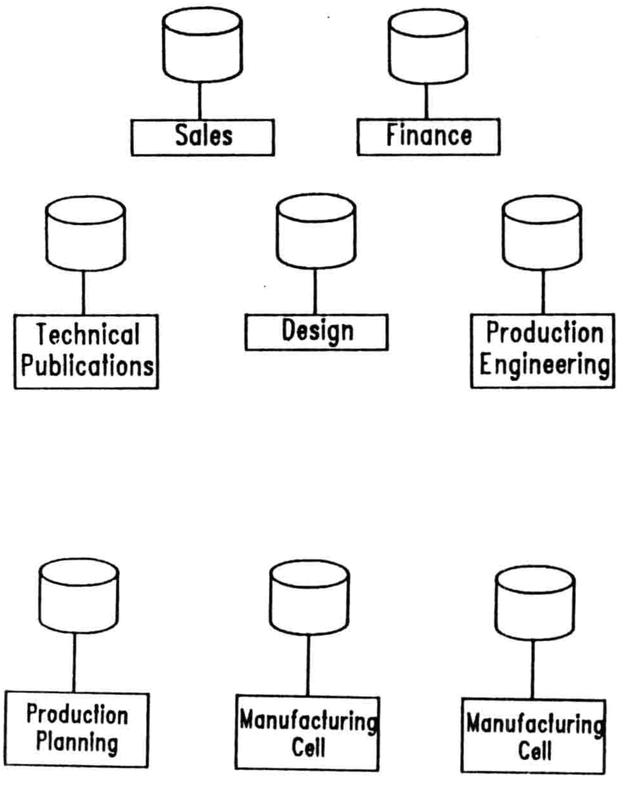

Figure 3 Today's Environment - Islands of Automation

CIM – Range and Reach

Having mentioned the need for integration this chart goes directly to a scenario of a company which has implemented CIM. It indicates that the flow of materials from supplier through all the pertinent operating depts., through the distribution chain until the end-product reaches the customer is matched by the information of a single system. It does, in fact, extend somewhat further than this since a good CIM system should be capable of taking customer queries regarding for instance, modification of an existing product, producing a new design with associated production specification and costing enabling a speedy response to the enquiring customer and hopefully gaining that order for your company. Such systems are in place and there will be many more over the next few years.

Necessary characteristics of such a system are that whilst each dept. performs its own tasks using information specific to that dept; that information is but a subset of the total information base for the company. The advantages of such a system start with being able to respond quickly to sales queries as discussed earlier but they continue through with accurate status reports, usually on-line, of the position of an order currently in process, its likely completion time, variance against material and cost standards and so on. Where the need arises it also forms the basis of a system of order history. Showing the equipment, material, operators and other relevant information concerning a specific batch or order manufactured maybe 10 years ago. Such systems are very necessary in for instance the Aero and Pharmaceutical Industries and are probably near the top of the wish list of Tyre Manufacturers.

Business Action/Reaction

The final chart in this section illustrates the balance which has to be achieved between product volumes, costs, revenues and various other parameters in order that the profit line looks good and stays good.

The chart is applicable to each and every company represented here but the emphasis on the individual factors will vary from company to company.

THE ENABLING OF SUSTAINABLE BUSINESS ADVANTAGE

The last ten years has shown that IT can be the source of competitive advantage for companies that have targeted a certain part of the market place and set in place strategies incorporating IT to achieve those targets.

Since many of the companies represented in this seminar are by definition in competition with one another I have specifically chosen my examples from other industries.

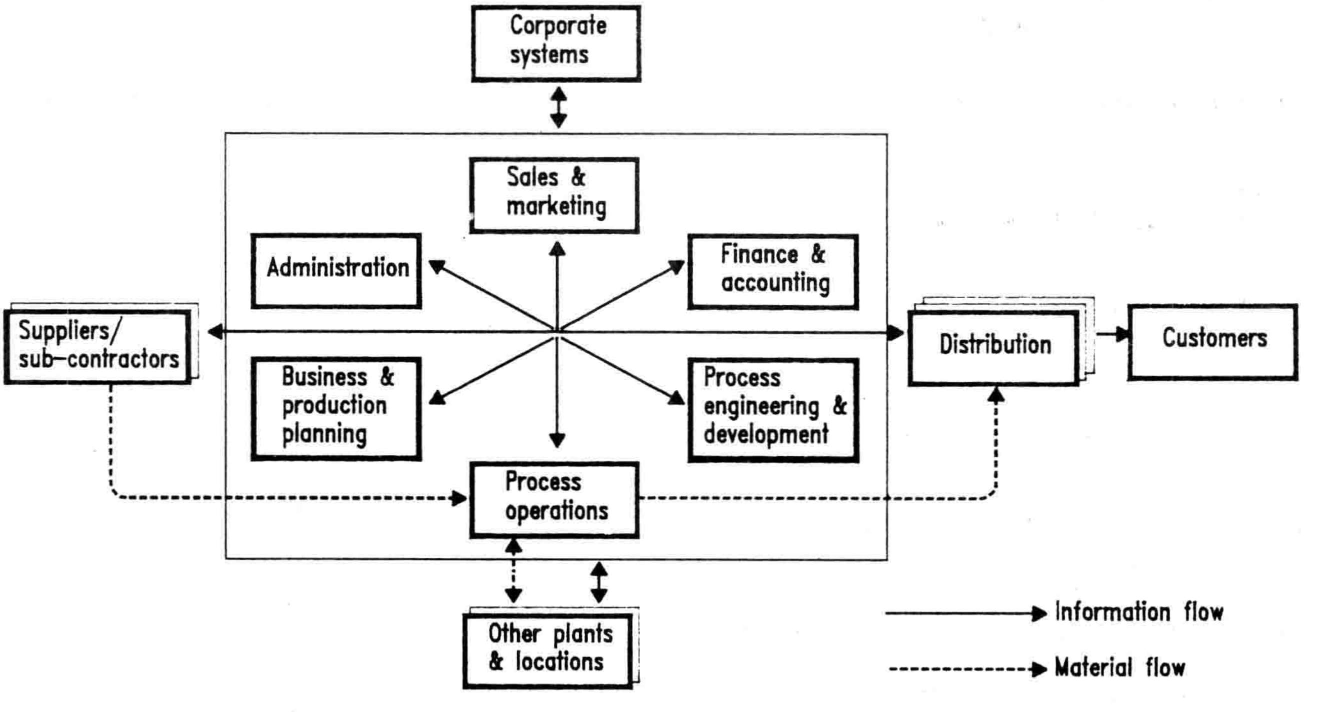

Figure 4 CIM – Range and Reach

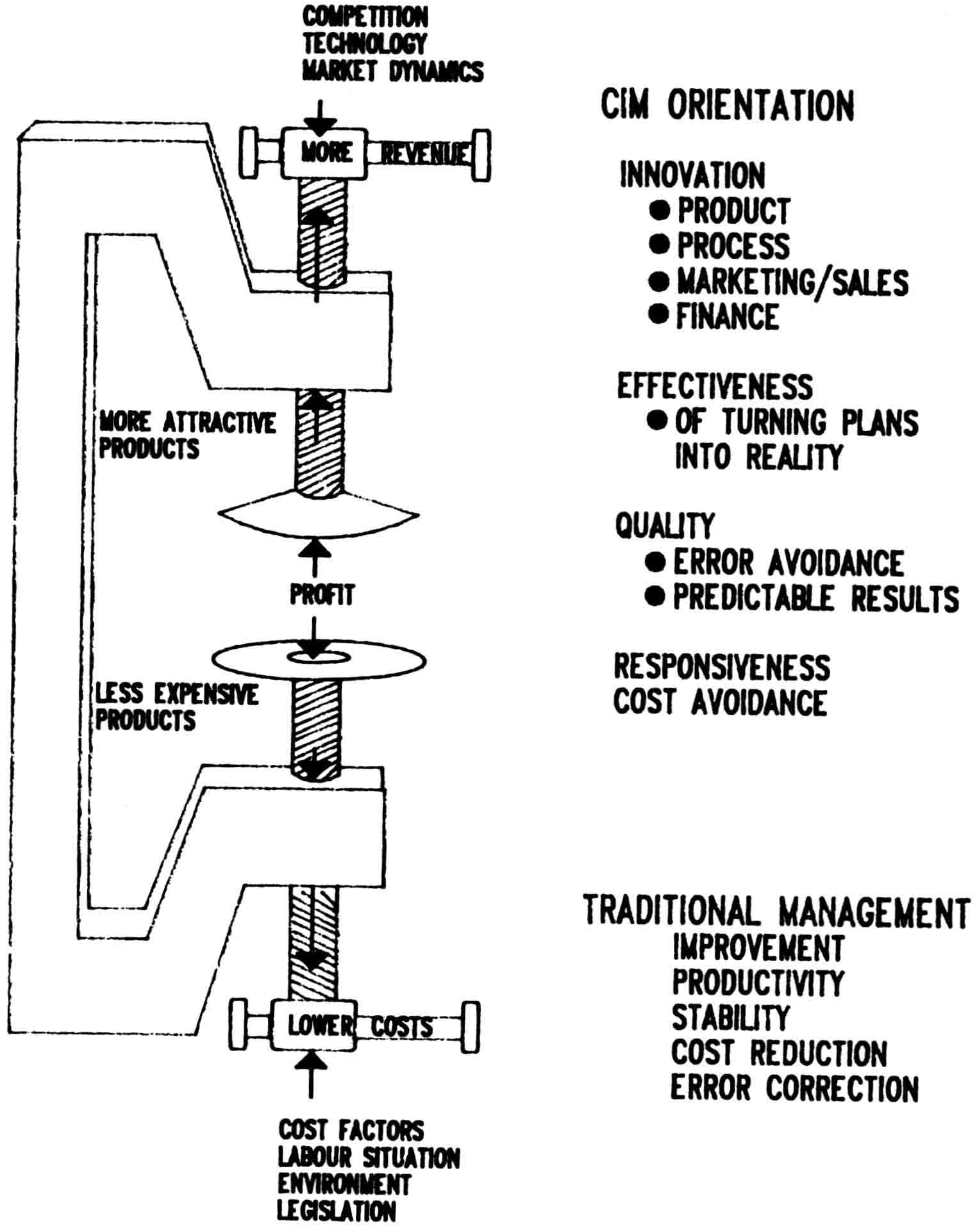

Figure 5 Business Action: Reaction

To quote just a few:

Hospital Supplies:
A hospital supplier agreed to place a VDU on the desk of every purchasing manager, free of charge. The main information shown on each managers VDU was prioritised so that the suppliers own products were shown first and were highlighted. It goes without saying that this specific supplier achieved a rather larger share of the business from those hospitals than did his competitors.

Airline Bookings:
A similar philosophy to the above has been adopted. In this case the key concern is ensuring that a specific seat utilisation is achieved. Thus not only does our specific set of flights be highlighted but the take-up rate can be carefully monitored to enable special offers to be available in good time to fill the vacant seats.

Automotive Repairs:
A PC-based information system was developed by a paint manufacturer for use in car body repair shops. The repair shop keyed-in data about the make, model, original colour, age and condition of the car. From this the PC produced a detailed specification of precise colour for the car in terms of the paint companies part numbers. This gave the company a lead of several years and also tied in the repair shops to this supplier for a period of time.
These are just three of many examples of IT giving a company competitive edge.

PRODUCT RELATED

- DIFFERENTIATION
- EXPLOITING NICHE MARKETS
- INFLUENCING COSTS

MARKET RELATED

- LOCKING-IN TRADING PARTNERS (AND LOCKING OTHERS OUT)
- CREATING NEW BUSINESS
- CHANGING BUSINESS PROCESSES OR THE POWER STRUCTURE OF THE INDUSTRY

Figure 6 The Enabling of Sustainable Business Advantage

CEO'S 'I Insist' List

As you will all know it is not sufficient to have a good idea; success depends to a overwhelming extent on the implementation of that idea.

Most of the examples discussed herein made radical changes to the modus operandi of the companies concerned. The last chart gives a number of guidelines for the adoption and implementation of such systems but perhaps the most important aspect is contained in the title.

This is the Chief Executive Officers list; his commitment must be total and must be perceived to be total at all levels from the shop floor to the board.

The time is past when the computer was a useful tool for performing minor functions within the company. In successful companies the IT strategy is an integral part of the Corporate Strategy; it would be unthinkable for the Corporate Strategy of any enterprise to be decided without the commitment of the CEO and his board; their involvement is as essential for the mandatory IT ingredient/component. The IT strategy truly is the keystone of the Corporate Strategy.

OUR IT INFRASTRUCTURE SHALL :-

1) NEVER BLOCK BUSINESS INITIATIVES
2) BE ADAPTIVE TO RESTRUCTURING, RE-ORGANISING
3) ENABLE SWIFT REACTION TO COMPETITIVE IT ADVANCE
4) ENABLE MAXIMUM ALLIANCE OPPORTUNITIES
5) MAKE OUR INTEGRATED SYSTEMS HARD TO COPY
6) BE CAPABLE OF EXPLOITING ALL EVOLVING TECHNOLOGIES
7) BE ABLE TO HAVE TRUE, GLOBAL REACH
8) BE MANAGEABLE AND CONTROLLABLE

Figure 7 The Senior Management Policy Agenda (or the CEO's 'I Insist' List)

New Technology in Control of Mixer Feed Lines

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INTRODUCTION

Ten years ago the microelectronics revolution began to make an impact on control systems for rubber compounding. Low cost controls made the adoption of the new technology inevitable. The power and flexibility of control via software became apparent to every manufacturer regardless of size of operation.

It was the end of the era where the plant maintenance electrician fully understood how it all worked. The computer programmer and his software became king.

The choice of a new Mixer Feed control system is primarily based upon the suitability of the software to the users needs, the cost of that system, and the reputation of the supplier to support the installation.

Little importance is placed upon the operating system that lies behind the software or the networking standards used within it.

The importance of these two factors is about to dramatically effect the choice of any new systems. New open interfacing standards are emerging which will enable computer systems from a diverse range of manufacturers to be linked together successfully. Operating systems now exist which will enable software to run independently of any given hardware manufacturer. These operating systems in turn force the pace of open interfacing standards, as they are no longer shackled by marketing practices of a single computer manufacturer.

As these new software standards become incorporated into the control system they offer greater interfacing capability by definition, and because they run on a powerful industrial PC they offer considerable power and flexibility. This in turn cuts the cost of an overall control system because the costs of customisation and interconnection diminish.

THE EMERGING STANDARDS

The sheer size and operating speed of todays personal computers in business puts them in a category which enables them to use operating systems designed originally for mainframe computers. These operating systems offer multi tasking and multi user operation as well as providing a wide range of support software.

Their superiority of operation and their computing power compared to say a single user sequential task operating system such as DOS, quickly becomes apparent to the systems designer.

The front runner in these powerful operating systems is the UNIX family which already overshadows competitive systems such as VMS or OS/2. UNIX is supported by an impressive range of computer manufacturers so it also has the benefit of being truly hardware independent. Being a front runner means that a lot of software already exists which is UNIX compatible and is public domain (very low cost as no royalty payment is required).

Like all major systems it has been around for a few years so it is relatively free from problems, and new revisions are well tested prior to launch.

Over the last few years major manufacturers have also been trying to develop standards for computer interfacing. These new computer intercommunication standards are known as the ISO 7 layer model. It aims at setting standards for all systems interfacing, regardless of the source of manufacture. Up until recently only the upper layers of this model had been implemented in software packages, a set of which exists for most implementations of UNIX. These layers define the intercommunicating message formats and structures, arbitration techniques, etc. The lower layers define the hardeware of the network itself from the physical properties of the wire, through the frequency, band width, the hardware protocol and the data recognition. The Japanese are soon going to launch hardware chip sets which will provide a low cost vehicle for these lower layers.

Their incorporation into the design of the computer hardware when used in conjunction with existing software will herald the realisation of a truly OSI standard system.

HARDWARE INDEPENDENCE

The advantage of basing a control system on one of the dominant operating systems is two fold.

Firstly it is hardware independent. Todays computer hardware has an incredibly short product life cycle before it is made obsolete by the next generation machine. The cost of updating to the next machine is also dropping all the time.

Hence if the control system is designed in such a way that the computer hardware can be easily unplugged without disturbing the plant wiring, then updating the hardware becomes trivial. More importantly if the existing software will run on the new hardware even though it is from a different manufacturer then true independence is achieved.

Secondly the software within these operating systems evolves as new revisions incorporating new features and facilities.

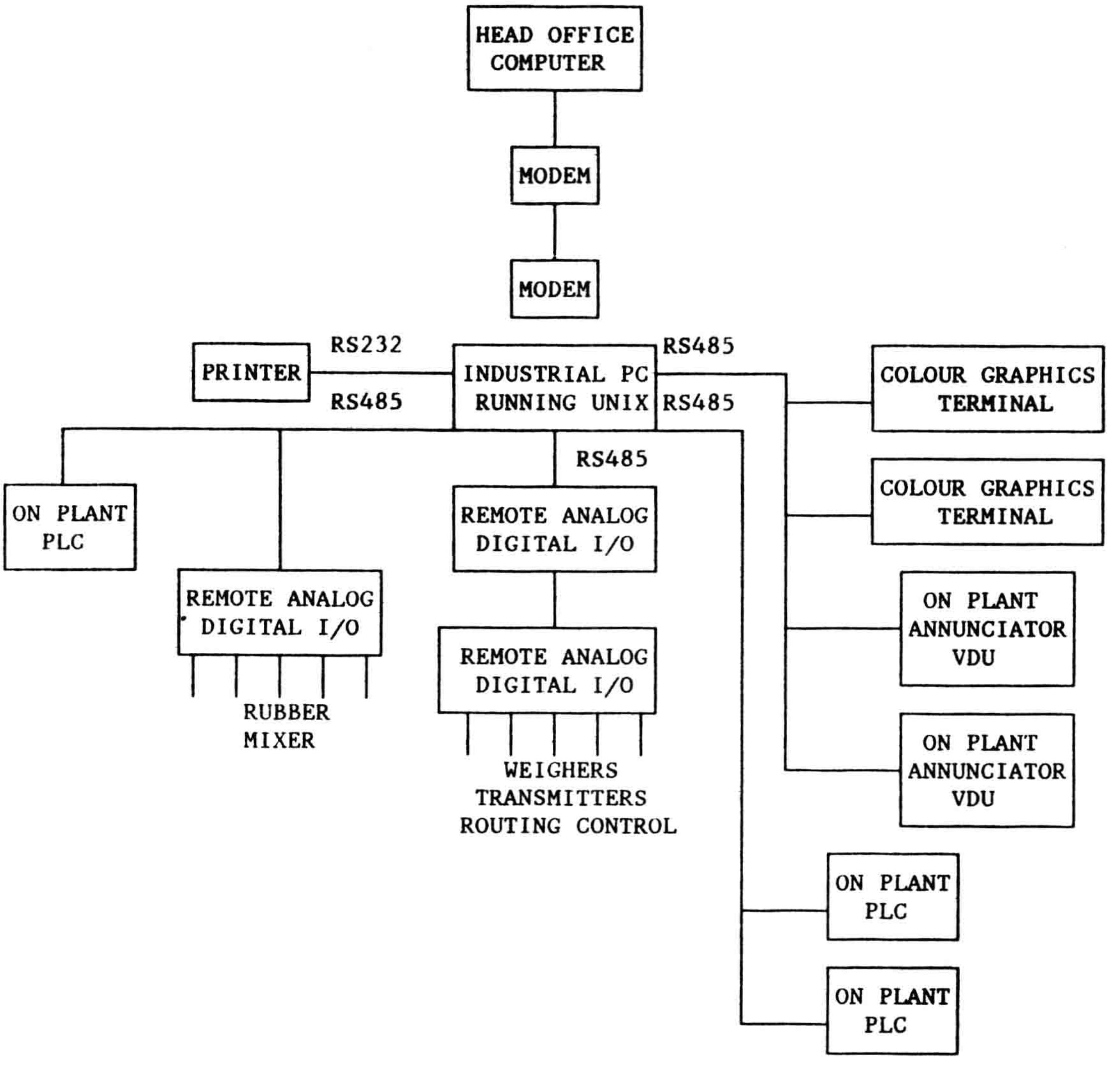
Therefore not only can the hardware update create more space and more time, but that space and time can be filled to maximum commercial benefit by running additional control or business software, including the use of new standards which are gradually gaining universal acceptance.

DISTRIBUTED CONTROL

Much has been written over the years arguing the pros and cons of distributed or central control systems. Large operating systems operate on a time slice technique to provide reasonably rapid response to multi users and multi tasks under the control of the operating system. By definition therefore they cannot directly control the process as they would be too slow for activities requiring a 10 ms response such as weigher cut off control for precision weighing.

Hence the need for distributed control whenever these operating systems are used is no longer a debatable point, it is essential.

Distributed control nowadays also offers considerable simplicity of installation. The input/output interface rack can be housed close to the motor starter panel to significantly reduce the plant wiring cost, and a simple twisted pair cable running high speed serial communication daisy chains around the plant terminating in the controlling computer. The controlling computer will more than likely be a powerful industrial PC chassis from a well known supplier.



REMOVING THE MYSTIQUE

A well designed mill control system should provide facilities to make both operation and modification simple with a little non specialist training. The operator should never be left wondering which key to press next. Windowing techniques on colour VDU's can make menu selection or general input commands simple and obvious.

Critical information can be highlighted in clever ways, data on levels below the windows should not freeze, and mimic should clearly indicate exactly what is running and what is stopped.

The Engineer should be able to easily access the system in order to change it. This may be updating a mimic to include a new plant item or new feature, or altering a PLC sequence. Printed reports can nowadays be based on a Lotus or equivalent spreadsheet, so that it can be taylor made to suit the individual Mixer Feed Line at the wishes of the Engineer or Chemist.

CUSTOMISING WITHIN A BUDGET

Getting the best solution at the right price is the ultimate goal. The system shown above should go a long way to achieving this goal as it combines the following:

- Distributed computing such that if any part should fail the remaining units will still operate successfully with minimised degradation.
- No element of the system is unwieldy in size or complexity.
- No element of the system is unduly expensive to purchase or maintain.
- The system can be added to at a later date when new items can be purchased.
- The software of the central processor is designed to facilitate changes by the users Engineering staff after a short training course.

It is the last item that warrants further explanation as it finally removes the need to employ expensive specialist staff to customise the system and keep it current.

USER CONFIGURABLE SOFTWARE

No two Rubber Factories are the same. Requirements vary significantly from batch weighing or final stage mixing only, to complex synchronised multi batch weighing and mixing lines.

The software provided by the manufacturer cannot therefore offer all features required by all mills. The user on the other hand cannot afford the time or the money to engage in massive live order engineering of that software. The solution to this dilemma lies in designing the software in such a way that those parts of the system which are likely to require modification can be done quickly by a non specialist in the following manner:

- Scale configuration done via a series of questions and answers through the keyboard which both allocates the scales parameters and their function.
- Displays constructed from editing the screen by starting from one of a number of predefined example screens to create the additional customised data.
- Colour graphics similarly created or edited from a series of predefined examples.
- Reports generated in conventional spreadsheet manner from a list of variables. Report content, report style, and report frequency can all be changed to suit the user.

TIPS ON AVOIDING THE DINOSAUR

We have all come across these systems. They are big and expensive and they become extinct in 5 or 6 years from installation. They are usually supplied by a big computer specialist and swallow man years of customised software. They overrun the timescale and the cost targets and they are bad news for both parties. How are they to be avoided?

- Do not get hung up on the conventional offering not having the exact features you want. They are designed for a general market, so think carefully. Have you got to have the feature? Can you pay a bit more to have it included? Is there another way to solve the problem?
- Avoid the one off's. The computer or PLC manufacturer is a well known name, but have they got proven installations? Has the computer/ PLC already directly controlled weighing machines.
- Look at the long term. Where will it take me in 5-10 years? Can you keep expanding it or do I throw it all away and start again? If I want to make changes in a few years time, is it easy or will no one want to know?
- Choose a distributed system where elements can be updated without too much difficulty so the hardware stays current.
- Make sure it has a universal operating system supporting multi user/multi tasking like the UNIX family. This will allow the continual development of your software to outlive todays hardware.

- If a PC based system is chosen avoid using the really low cost offerings. These systems suffer from the following inherent problems:

a) They are housed in a cheap plastic or GRP cabinet which is not suited to the harsher mill environment even in a control room. An industrial chassis is recommended.

b) The cheaper systems are made to a cost by cramming as much as possible onto a single PCB motherboard with expansion daughter boards. It is OK today, but in a few years time if the PCB fails can you get a spare if the model has changed many times since it was purchased? Will a new model support the old software? Some claimed compatibles simply are not. A system with a passive backplane enables AT cards from many manufacturers to be plugged in. These cards by definition of the way in which they are sold are standard, and have a longer product lifetime.

c) Inadequate underated power supplies of cheap systems are usually the main course for failure of the system.

- Enlist the help of a computer consultant if you feel out of your depth. It is money well spent if you are planning a major investment. He will hopefully steer you clear of the short lived solutions which lack the ability to be hardware independent.
- Finally get hands on experience with your favourite system before you buy. Get your technical people and your maintenance staff to programme the PLC, generate a new colour mimic and modify the control strategy. After all the Salesman told you how easy it all is. Make him earn the sale.

Computer Control for the Internal Mixing Process

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1. INTRODUCTION

The internal mixer has been a central component of the rubber compounding industry for many decades, during which it has evolved into a highly engineered item of equipment. The advent of appropriate computer-based technology in recent years has provided a major new path for advance: the control of the mixing process itself.

This paper describes a number of aspects of the development of computer control for the internal mixing process, based largely on the experiences of Francis Shaw & Company Limited in implementing such development.

2. THE DEVELOPMENT OBJECTIVES

In order to set the objectives to be achieved by any attempt to control the mixing process it is first necessary to examine the overall requirements of the user of the mixer. In general, the manufacturer of rubber products serves a market demanding improving quality at reducing cost. While manufacturers have responded to this economic pressure in individual ways, the underlying approach is typically that presented in Figure 1.

It is now understood by the majority of mixer users that the mixing operation must produce, with maximum efficiency, a compound that has excellent distribution and dispersion of its constituents and has a viscosity and a heat history that consistently meets specification. These demands have been referred back to the machinery supplier where they have served as the objectives for development of the equipment.

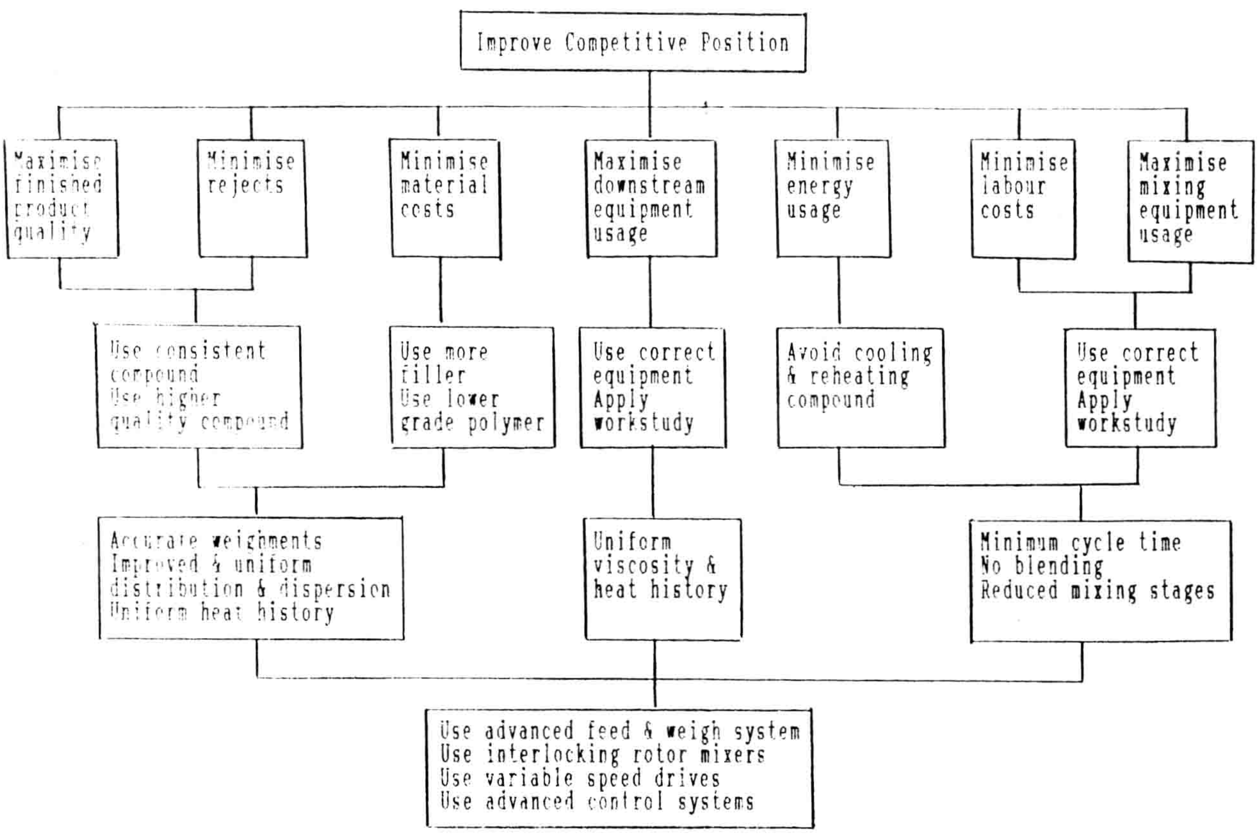

Figure 1 Typical manufacturing strategy within the rubber industry

The mechanical engineering design of the internal mixer has been optimised over many years to provide the levels of dispersive and distributive mixing required by users. The attainment of consistent viscosity and heat history is the province of control technology.

3. THE PROCESS TO BE CONTROLLED

The internal mixing process is a batch mixing operation. As such it is cyclical in nature, following carefully prescribed patterns of operation in adding and mixing the various materials being compounded. An example of the variation in compound rheology during a typical mixing cycle is presented in Figure 2.

The complex interactions between machine and compound are not yet fully understood, with obvious implications for the design of appropriate control systems.

The attainment of consistency in viscosity and heat history within a batch and from batch to batch is complicated by the following:

a) The rheology of the principle feedstocks, rubber and carbon, may vary widely from batch to batch. This difficulty, which is acute in the case of natural rubber, means that simply controlling the machine along a consistent operational cycle will result in the variations in the input material being reflected in similar variations in the output material. While tightening the specifications and quality of the feedstocks to ensure more uniform products is obviously desirable it is circumscribed by economics. It thus remains essential to consider the actual viscosity of the material in controlling the mixing process.

b) The volumes and concentrations of the materials being compounded change during the mixing cycle as constituents are added and as they are forced or drawn into the mixing chamber. Additionally, the net volume of the materials is limited so as never to permit the full occupation of the free volume of the mixing chamber. These factors result in a random interaction between machine and material with the result that the machine must be operated relatively inefficiently (mixing cycles extended) in order to ensure adequate mixing throughout the compound. Considerable effort has been expended in developing machine geometries that will maximise the uniformity of mixing, but the factor remains consequential.

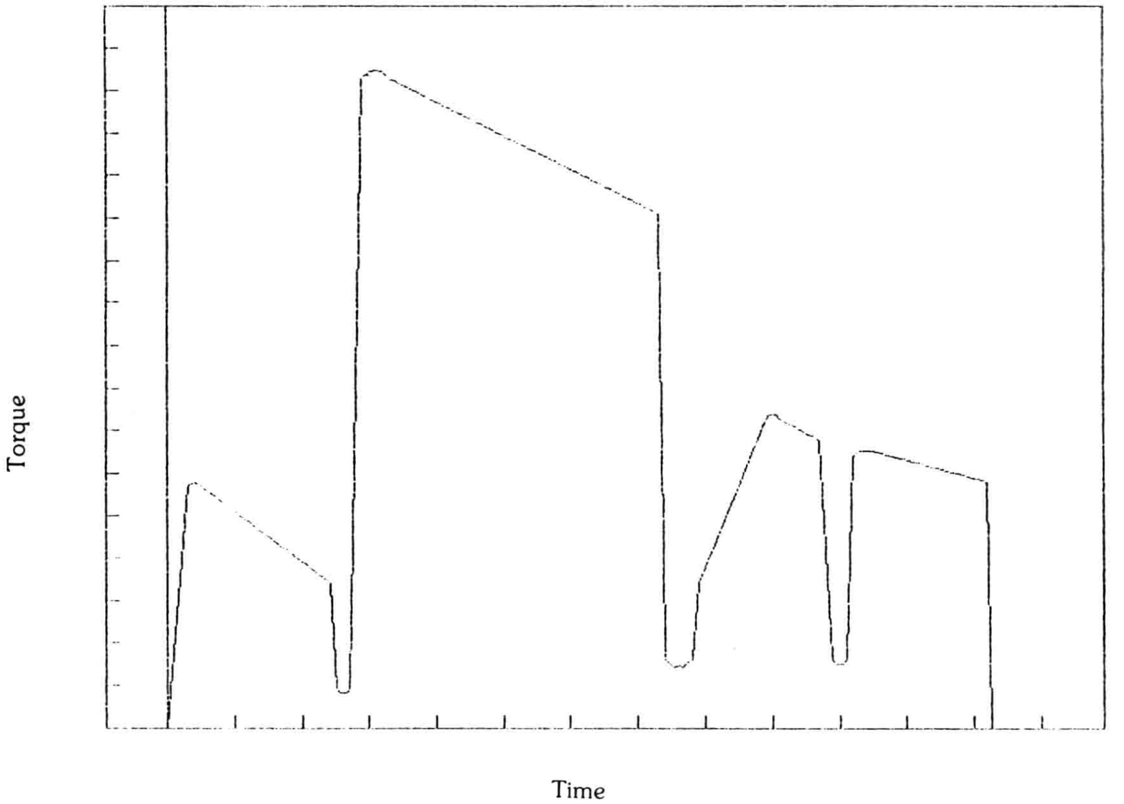

Figure 2 Torque variation over cycle