# ADVANCING MEDIUM SIZE MANUFACTURING ENTERPRISES THROUGH MANAGEMENT BY ENGINEERS

by

Edward John

**Edward J. Colville**
**B.Mech.E, M.Eng.Sc, F.I.E.Aust, CPEng.**

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**School of Engineering**
**The University of Tasmania, Australia**

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**Declaration**

This thesis contains no material that has been previously accepted for a degree or diploma by the University or any other institution, except by way of background information and has been duly acknowledged in the thesis, and to the best of the author's knowledge and belief no material has been previously published or written by any other person except where due acknowledgement is made in the text of the Thesis.

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## ABSTRACT

This thesis sets out initially, under the headings of key departments and auxiliary functions, the principal areas of business knowledge and personal communication required to augment technology skills. The aim of this portion of the work is to provide a checklist for the development of engineers so that they can prepare themselves to embark on a career in senior management with confidence. The necessary skills are defined in terms applicable to specific departments within an enterprise rather than confine comments to a generalised statement. The first responsibility areas discussed are the board, the general manager and the key operating departments of marketing, production, finance and coordination of services. The many services, the catalysts of industry available to management, are then examined in a similar manner, primarily to provide an awareness of the contribution they can make either on a regular basis or as the need arises.

While the principal technology and applied science principles provided through an engineer's tertiary training are of major importance it is shown from the analysis of management needs that many knowledge areas and a broader understanding of other professional skills are necessary additions to an engineer's background if he/she is to manage successfully. This is not to underestimate the logic training and an understanding of the scientific principles, mathematics and designs associated with management techniques which have already been acquired by engineers. However business knowledge is also a key ingredient for a manager, and when combined with a knowledge of the technology of an enterprise, can provide excellent management. A greater accent on people and finance in addition to preoccupation with "things", may have to be cultivated by engineers to be effective managers in industry and commerce.

It can be seen from the summary of the departmental planning and communication needs that the major importance of overall planning, policy making and motivation to promote and implement action are clearly at the heart of the business management required. A method of tackling these needs is presented involving the preparation of budgets and encouragement of participation by all those responsible for their implementation throughout an organisation.

The development of the "Budget Support" system designed to meet this need is described and its basis presented by the author. The course of the team research and development which has resulted in its current user friendly form is explained. Case studies follow showing the part the budget simulation of the total financial affairs of a company has played over thirty years of changing industrial climate. The program has enabled a manufacturing and service company to be managed economically by producing staff cohesion, cost standards and the integration of its affairs through its master planning capability. The application of the simulation to feasibility studies to determine which direction a whole business should take has been demonstrated. In

addition as a business training procedure it has enabled many engineering students both undergraduate and post graduate to learn of the interacting facets of a manufacturing organisation. During this time the author has occupied the roles of technical manager, administrative and general manager, company director and management consultant as well as a tertiary engineering educator allied to the development of the simulation.

In conclusion strengthening the potential of engineers to manage businesses is advocated and recommendations made as to how this can be expedited. A greater emphasis on combining business knowledge with technical skill through management by engineers will benefit Australian manufacturing industry and enhance the career opportunities of many engineers.

# CONTENTS

# CHAPTER 1

# INTRODUCTION

This thesis is concerned with the needs of an engineer in industry to compliment the technical skills and disciplines of his or her tertiary training and add to piecemeal information acquired from experience later. Important skills obtained at this early stage include the logic training that is inherent in the mathematics, physics, chemistry, language and social studies of formative years.

## 1.1 BACKGROUND TO THE NEED FOR MANAGEMENT SKILLS

An engineering course builds on these items with more mathematics, thermodynamics, structures, electrical and electronics, fluids, and pneumatics, solids and materials, dynamics and engineering processes. Some courses accent production and project planning, quality control, systems and further applied work such as robotics, hydraulics, automation and statistics as well as advanced measuring and surveying techniques.

There are faculties which regard work in industry as obligatory during the course while others consider that this is a matter for later experience. The importance of maintenance planning and methods of maintenance scheduling are emphasised in most courses. Stress analysis in structures and solids and the metallurgical structure and design of components to be manufactured for a particular application are also included in the experience of many engineers.

The calculus and applied mechanics required to calculate and design for a range of conditions and processes is in most courses. Such items as dynamics, thermodynamics, systems and the design of rotating machinery, electronic circuitry and automobiles are important in these courses for the professional engineer. The design of pressure vessels and chemical engineering equipment to meet optimum production requirements is included or can be carried out from first principles. In addition there are subjects such as operations research to assist decision making and ergonomics and bioengineering to assist the design of work place and medical techniques. The writing of reports and getting projects done on time, learnt as part of an

engineering course are key ingredients for future industrial careers. There is also the emphasis on information technology, computer hardware and software, the application of systems theory and the processing of data to provide information to facilitate decision making.
In more recent years some management studies and engineering economics subjects are appearing in the more advanced engineering faculties so that one might well ask; Where are the gaps?. This problem has belatedly been recognised by such people as lecturers specialising in manufacturing management at Harvard University.[1] They are now advocating that technology skills of a particular industry are required as well as business skills for effective management of a technology based enterprise. This conclusion comes following the perpetuation of the erroneous idea that "management training" from a management college without technical knowledge will equip one to manage anything. This view has held back manufacture in anglo-saxon heritage countries in many instances both in Australia and overseas just as the specialist technologist without business knowledge also has difficulty as a business manager. Clearly the need is to have both business and technology skills to manage a manufacturing firm. It was the need to clarify and set down both the business knowledge and personal skills which can add to the skills of the engineer which stimulated the preparation of this thesis. The engineer can acquire business skills relatively easily because of his/her training whereas the solely "management trained" individual is at a loss in many engineering based industries. Sections of chapter 2 are to provide a check list so that for engineers can appraise their skills against management requirements for particular departments of a firm.

Starting with thorough engineering and logic training and adding the business knowledge and personal skills outlined in this thesis will, in the opinion of the author, yield better results in our industries using engineers in management positions. The reverse procedure of trying to educate commerce, accounting and legal professionals about engineering later in their careers to enable them to efficiently manage industries with rapidly advancing technology and changing products and communications does not appear to have proved effective in practice. This latter procedure involving the appointment of non-engineers into industrial management and board positions is however taking place on a substantial scale in Australia in the belief that they can manage without having to have technical knowledge. Loss of some of Australia's most promising value adding activities to overseas interests, in particular in the

food processing area, [2] is symptomatic of the failure of limited industrial management in these cases.

## 1.2 GAPS IN KNOWLEDGE AND APTITUDE AND THE NEED FOR A COORDINATING APPROACH

Of the gaps the most important for young engineers is experience in actual application of many of the practices only explained in theory and demonstrated in limited laboratory studies. Some of these are provided by family background and daily interaction with fellow students and specialist lecturers but these lecturers are often not in industry or have only minor experience in practice. A most important facet of this gap is the ability to work with others in the field in a real industrial situation to get things done with and through people. Gaps can also occur in technological skill but these can usually be overcome by application to further reading and study since the engineer has the basics to comprehend a new development. This latter need occurs of course throughout one's technical career.

The knowledge of how to operate in, and understand, the infrastructure of a firm, communicate with staff at various levels and lead an organisation all require further knowledge. In addition, at the general manager and board level, there are skills which the young engineer needs to develop if he/she is to take their place in these positions later. In this thesis it is proposed to set out these skills as chapters, in accordance with the management chart figure 1, which show where skills fit into the structure of an enterprise, and the complementary activities of figure 2, which sets out the chapters describing the major contributors to effective communication and planning within an organisation. Not only are the skill areas of figure 1, important as pieces of information and tools which assist particular departments within management, but of equal importance are the "catalysts" of figure 2 which lubricate communications and allow information to flow throughout a firm. They make leadership effective and assist an organisation to adjust to change. Of particular importance is the coordination of forward planning budgets which is the subject of chapters 2.7 and 2.8, and chapter 4, has been the subject of significant research by the author over more than 20 years. The result has been the combination of both a technical and a participatory approach to managing the coordination of a company's plans to achieve its objectives.

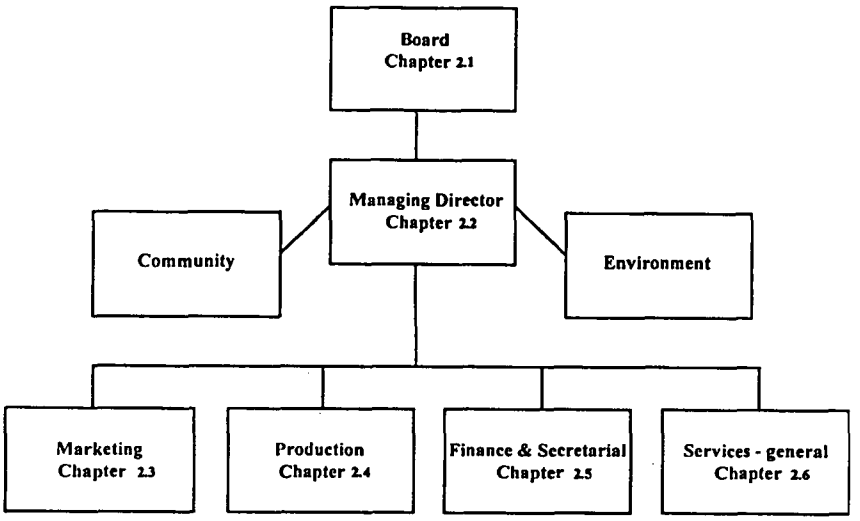



**Figure 1. Chart showing knowledge areas within a conventional organisation chart which are presented as sections of chapter 2, Sections 2.1 to 2.6. These chapters clarify departmental management requirements.**

Industry has become more sophisticated and complex, technically and socially, and its information services are now critical to its management. At the same time computing facilities have become more powerful and less costly. These factors have led to the development of information systems which transfer "data" into "information" to provide marketing, production and financial control staff with reports which summarise the key components for which they are responsible. While this process is well understood by engineers the design of the process requires a knowledge of business outcomes required as well as the process and technology of providing information. This information flow has led to a change in business structure in which the degree of hierarchical control needed in the normal situation has been reduced as more information allowing direct local action is spread throughout an organisation.

A management information system based on a simulation model of the firm can trace its expected sales, production and financial movements as well as its balance sheet and potential

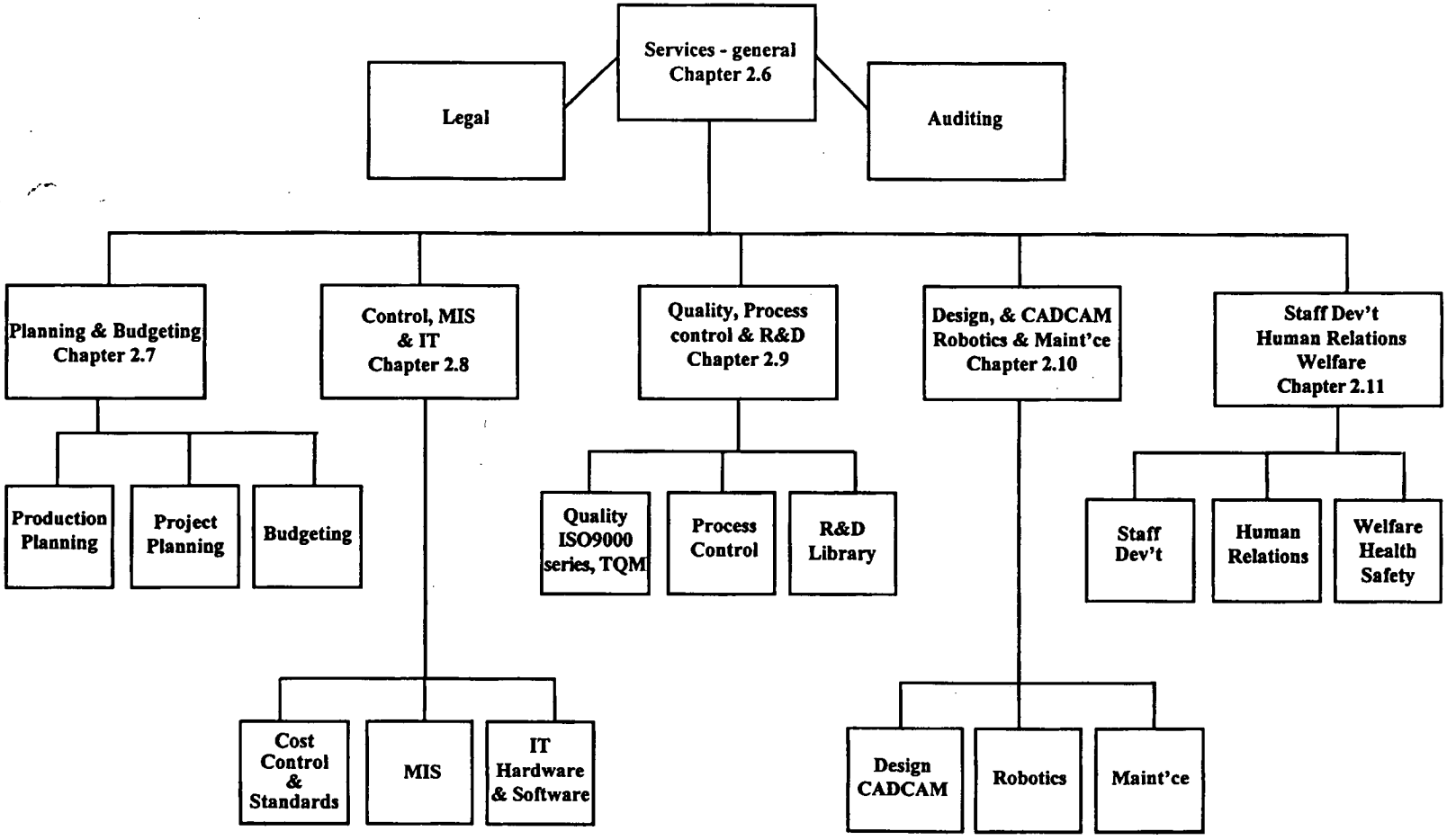



Figure 2. Chart showing "catalyst" activities which complement departmental and general management and are described in the chapters shown.

changes to these items. Modern spreadsheets for data assembly add to the more detailed software of the simulation to facilitate this process. The importance of this approach, as already emphasised, has been developed as a Budget Support System by the author and is briefly described in chapter 2.7 and its use as part of an MIS outlined in chapter 2.8 with a detailed description in chapter 4.

# CHAPTER 2
# LITERATURE SURVEY, PAPERS AND EXPERIENCE

This section covers each main facet of business activity including **A**, direct operating departments and **B**, services encompassing planning and budgeting.

## PART A PRINCIPAL DEPARTMENTS

Each section of this chapter includes general comment, comment applicable to an engineers need in occupying that responsibility and economic and cultural aspects associated with that section's management.

## 2.1 THE BOARD MEMBERS

### 2.1.1 Policy Formulation

The board, that is the company's directors, are elected by the shareholders to represent their interests, define policy and control the management of the firm on their behalf. Whether one regards this as solely in the interests of the shareholders or partly on behalf of the community in which they operate will continue to be debated about capital based businesses. What is clear is that customer, employee, supplier and environment pressures as well as government legislation needs to be taken into account when policies and management methods are being defined and implemented.

Rules of governance are now receiving greater emphasis in many of Australia's public company activities to control the measure of self interest which can be applied by directors. These rules of conduct are provided by both government, representing the community, and by shareholder associations to see that feed back and performance reports are balanced and accurately reported.

A primary task of the board is to formulate policy. A policy is defined as a directive which covers a multitude of decisions such as " Our operations are to concentrate on the automotive industry" or " Our long term borrowing commitment is not to exceed 30% of our total assets".

( 45% is on the high side for this gearing ratio). These policy decisions are to provide firm guidelines for the general management and the executives of the firm as they pursue the operations of the business. Aims, such as achieving a particular market share to assist price stability, and the need to invest in exports, and open up overseas offices are typical of long term strategies a board might present to its management.

Another financial matter, which occupies the attention of many public company boards, is the extent to which the company is vulnerable to predators. On the one hand sufficient reserves, often in the form of separate readily realisable investments, need to be kept in case these are needed for asset investment or down turns in the business cycle. On the other hand if these reserves are too high the shareholders may wonder why these reserves have not been paid out as dividends and try and unseat the board members, or the reserves may attract takeover merchants who see a lower than normal share value combined with loads of ready cash potential in the company and try and take the company away from the existing shareholders by purchasing a majority of the shares through the stock exchange.

The rate of growth is a question the board needs to keep in mind. Some public company boards restrict growth to 10% because of the effect on costs such as overtime, lower quality and the inefficiencies caused by the need to introduce too many new staff over a short period. There is also the question of whether new investment in equipment and process is required and whether working capital will be sufficient for the growth planned.

### 2.1.2 Company Formation and Corporate Structure.

To understand corporate structure and its implications it is useful to consider the financial background to various types of trading arrangements which explain the transition from a sole trader to a listed public company. Initially the sole trader's limits to growth will be considered followed by aspects of proprietary limited and public company structures.

**Sole Trader and partnership** The sole trader may register a name of his particular product or use his name for trading. He visits the registrar and checks that the name is available, pays a nominal fee and now has the trading name he has selected. He trades under that name and

the public can inspect who is the responsible person behind that trading name. He has sole responsibility for the debts, i.e. any amounts owed for the expenses associated with trading under that name. He can take these expenses, including car, phone and rental costs, from the income received to legitimately minimise his personal tax. He can be sued directly and if found to be liable is completely personally liable or, if he has insufficient funds himself, may cause any of his partners who have funds to also be liable for the debt.

In considering the question of sole traders, one starts from a small enterprise - often a back yard activity operating from a home or trying an idea out without becoming heavily financially involved. The business moves to a situation where other skills are involved or there is a need to double or treble the output required to cover the necessary overheads. At this stage in order to run this enterprise it necessary for the trader to be a combination of a secretary, a manager a receptionist for visitors as well as the person who carries out the actual production. This is an extremely hard life for the trader and without assistance and back up, or what may be regarded as protection, he can fail unless he resorts to an assistant who acts to give wise comment , copes with representatives and deals with customers, invoices, debtors and creditors while he gets saleable work done. In some cases the need arises for an alternative skill. The work might be welding and a fitter is needed to join the trader to complete the work.

Correspondingly, in the professions, there can be a need for the introduction of new skills. A legal practice normally involved in family law skills may need to be combined with skills associated with work cover. In architecture although the original concern was with suburban buildings there could arise a need for further skills in concrete structure design for city buildings. For a professional mechanical engineer design skill may need to be partnered by a specialist programmer to be fully effective. In any of these cases the potential partners get together and decide on their personal compatibility and integrity as well as their skills. It is important that the partners recognise any difference in working hours expected of each and have an agreement about this. The partnership should document any difference in investment between the partners. These items are set out in a partnership agreement with a copy in each person's hands. A key item for the partners is to acknowledge the difference between the

capital investment and the wage to be obtained by each partner. The first call is usually on the wages and if one partner is a silent partner that person should be aware that wage obligations come first, before any capital obligations, in the event of a break up of the partnership. The split of the net profit is also determined by the partnership agreement. A partnership is not necessarily half and half. Many partnerships have uneven equity such as 60% one person and 40% another, and some have many members .

As with the sole trader, taxation arrangements are such that the partners are considered to be trading as individuals and net profit is divided in proportion to their agreement for tax purposes. Legitimate personal expenses incurred to conduct the business can all be regarded as costs when calculating net profit of a partnership.

The key point about a partnership , as with a sole trader, is that on financial grounds all the partners are vulnerable. If, for example, a partner has made an unwise decision in signing a document legally binding on the partnership all the partners are involved. Should there be a liquidation, those creditors who are attacking the partnership can find which person holds funds, such as a house, and make that person pay the obligations of the partnership. It does not follow that the external obligation is divided in accordance with the partnership agreement. In addition, if people outside the partnership lend money to a partnership they are advised to have legal protection so that they are not considered to be part of the partnership. Some professional groups are required by law to remain as partners rather than be protected by having shares in a private company and operating as a separate entity from the partnership.

**Private Company** Reduction of financial risk for traders and access to investors needed to develop the business is the principal reason for the formation of a private, Pty. Ltd., a proprietary limited or limited liability company. Money can be lent to a private company provided the person providing the loan applies to the company for this purpose. Advertising for shares or loans is not permitted although a grey region can exist here. The company is a separate entity in law, in which shareholders have an investment. Unless guarantees are given by the directors, or unless some legally improper practice is being followed by the directors who represent the shareholders in running the company, the shareholders or loan holders are

not vulnerable and do not have to find money personally in the event of liquidation provided they had fully paid up the value of their shares. Liquidation can take place through no fault of the directors due to a severe economic downturn in the community for example and the private company protects this situation for directors and shareholders.

The formation of a private company is carried out by declaring to the company registrar, representing the public, the details of the new corporate body, providing details of its structure and shareholder obligations, its name, the purpose of its trading, the way the business is conducted, and its agreed initial nominal capital ( the total of the shares which can be issued without further application to the registrar). The executive officers and directors of the company as well as its registered office address are tabled so that a member of the public can inspect this data and decide whether they will trade with that company. These records are to be kept up to date throughout the life of the company. As part of the setting up of the private company the rules for its operation were previously defined and referred to as the articles and memoranda of the company but are now called its "constitution" although a constitution is not now compulsory for a private company.

The objects of the company should in general be set down combined with the nature of its share holding, its company meetings and the method of appointing directors or proposing major changes. A standard set of rules were originally set out as table A of the previous act [3]. While Table A stipulated that one share is equal to one vote, not all companies adopted Table A and investors should examine the constitution carefully regarding voting and dividend rights. In the case of a private company there is usually a clause restricting share transfer without the director's approval. In the case of substantial loans to the company rules to protect the rights of debenture or other loan holders may apply. Another form of control by lenders to a company is to arrange for a trustee who has the right to move into control of a company if the ratio of long term outside loans to total assets exceeds a particular ratio. This is to prevent such a case as that in which first mortgage debentures were offered to an extent which exceeded the total of the assets on which the lenders depended for their security.

A private company can grow from 2 shareholders up to 49. If more than 50 share holders is involved the company is a public company although not listed on the stock exchange. Typical of this situation is a cooperative group such as that which applies in some fruit growing areas.

As far as tax is concerned it is harder for a private company than for a partnership or sole trader because the taxation department regard the private company as an individual in law. First like all traders there is the sales tax, if the company is big enough there is the payroll tax and then there is the tax on company profits but some adjustment is proposed to this taxing system associated with a goods and services tax for year 2000 in Australia. The individual employees whether shareholders or not are finally taxed on their wages added to any dividends paid to them by the company. This makes it hard for the private company to develop its finances and leads to a further development in the event that the company expands rapidly and needs cash to either invest in new market opportunities or new technology. Not only is there a restriction on borrowing but the original entrepreneurs may have their personal equity tied up in the company in the form of stocks, machinery, working capital and loans and cannot use these items for such items as home purchase, leisure or education of their families even though the firm is operating at a profit.

There is a gap between the small private company and one which is large enough to enter the stock exchange. There is also the desire by the directors, and value to the company, of their retention of control and this has to be planned should the company be floated on the exchange. The answer, to overcome both the need for major funds injection associated with expansion and the personal needs of the original entrepreneurs, if the company is of sufficient size, is to float it on the stock exchange as a public company with a wide spectrum of relatively small shareholders. This allows a substantial increase in both share capital and loan funds and allows the same directors to control the board, provided they run the company well and reward shareholders satisfactorily.

**The Listed Public Company** Floating on the stock exchange takes place when a private company, after arranging for an accounting appraisal of its plans and approval of a prospectus outlining its plans obtains an agreement with a member of the exchange to back the float. The

stock exchange member receives a fee in proportion to the funds obtained and guarantees to find the agreed shares. The premium to be obtained, i.e. the extra amount on top of the nominal value of each share, is defined, in addition to any bonus shares to be allocated to the original shareholders based on the reserves locked up in the company prior to flotation. These bonus shares are a proportion of the difference between the net funds of the company just prior to flotation and the original value of the entrepreneurs' share holding. The public clients of the broker are given an initial opportunity to purchase shares, and later others can then buy shares in the company to add to the funds available for expansion. The new balance sheet shows the increased shares of the original shareholders combined with those of the new shareholders.

As far as control is concerned there are many fringe cases, based on the degree to which the public really controls listed public companies. If a group, for example, owns a 15% block of shares, it has a substantial say if the rest of the shares are widely spread. If it has 25% it virtually, under normal buoyant conditions, can control the company. If it has close to 50%, it could be argued that it should not be listed, because in effect it is no longer a public company and the individual shareholders' rights cannot be protected by the stock exchange rules within the normal course of events.

There has been a tendency in some companies, as with some government bodies, for the management to be so strong that it becomes relatively independent of the shareholders. In fact the company or department becomes an organism which moves along in its own right. In this case, the management may regard their shareholders as people to whom a suitable dividend is given, and that is the limit of the obligation. If the directors can borrow heavily at less cost than a dividend, they can even become independent of the shareholders by buying the company using their knowledge of liaison with finance houses.

As an example of share holding change because of a float, if the existing shareholders receive an extra share for every share they had originally and the float produces cash equivalent to the value of those two shares, then the net result is a fourfold increase in share capital and an injection of cash twice the original shareholders initial shares in the company. Should the

shares be floated at a premium, the new shareholders have to pay more than the nominal face value of a share to acquire each share. The idea here is that those who have built the company to a certain point gain some of the capital gain that has been achieved. The new group of shareholders may enjoy the same procedure at a later date, using reserves built up at the time of the float to provide a further capital gain. By this means, each new group can achieve a benefit due to an increase in the value of the net funds following their investment after an improvement has been made.

One of the reasons for requiring new investment in loans or shares is to grasp a new business opportunity, to purchase another company. One of the prime reasons is quite often that if one stays in a stationery position and technology advances or business opportunities are lost, the firm can actually lose all its past equity. A common occurrence for a business is to get into a position where it either goes forward or backward. There is no half way mark in many instances when a competitor is ready to take away potential market share in the immediate future. Waiting to accumulate funds internally from profits may take too long.

### 2.1.3 Board Responsibility

An important question for shareholders is to promote a balanced board. This involves astute selection by the original board and later its major shareholders in the selection of people with a knowledge of the market place and the industries in which the company is operating. Then there is the need for knowledge of the principal processes involved in making the firm's products. Finally there is a need for the financial and legal skills to steer the company through a minefield of commercial contract hazards when defining objectives. Sometimes it is necessary to have wise advisors rather than full board representation of the professions. Experience of managing and directing is also important. In general it is wise to have a predominance of "outside" directors, people who are vitally interested in the health and prosperity of the firm but not that close to the management team that they are parochial in their decisions and can counter the tendency for self justification by those who are senior staff of the company. The selection of a chair person by the board members, who can pull together the diverse views of the board members at their meetings, draw clear directives from the group, and ensure that the minutes of meetings clearly set out conclusions and promote action.

If it is a company policy to have strong independent directors as part of its governance then as a consequence the chairman should also be a non-executive. Executive director's salaries should be subject to a committee made up of a majority of non-executive directors. Follow up and penetration by directors if necessary by access to internal auditors, may be necessary to check relevant facts before they agree to, or ratify, new contracts.

Access to financial figures must always be available to the board members including auditor comment. This requires that direct access to financial information be available rather than the directors only receiving reports through the managing director / general manager. The managing director holds that position following appointment by the board and has a vote on the board while a general manager usually attends board meetings but does not have a board vote.

The style of the company is defined by the board through its method of negotiation and the type of contracts it approves as well as the type of company and people with which it negotiates. Absolute integrity is expected. Should a contract involve the board member personally, so that a conflict of interest exists, that director should decline to vote on that question and generally be absent at the time a vote is taken on that subject. A typical example is one where a supplier's contract or a property is being discussed and the supplier or owner is a board member, a partner of the board member or belongs to that director's family.

As already explained the company is constituted in accordance with a set of rules, its articles and memorandum or its constitution. The directors are elected by the shareholders in accordance with these rules, generally on the basis of 1 share being equivalent to 1 vote. These rules are usually comprehensive and allow the board, if it wishes, to define such activities as:

- Appointment of the chief executive officer and approval of the appointment of the firm's senior management
- Approval of the firm's organisation structure
- The ability to borrow and mortgage the assets of the company.
- The extent of borrowing permissible

- The rate of sales and production growth
- Control of capital expenditure to give a defined return
- Control of major supply and trade affiliations
- A measure of nomination of future directors and advisors
- Ratification of new products into the existing market
- Ratification of existing products into a new market
- Report on micro and macro-economic trends to management
- Encourage cohesion, enthusiasm and participation throughout the firm and the board
- Check that board policies are effectively followed within the firm
- Ensure that statutory requirements for the company are met
- To act as a role model for the staff of the company, in particular as far as integrity is concerned.
- Ensure that budgeted profits and adequate liquidity are maintained in short and long term
- Distribute a portion of accumulated profit to shareholders while maintaining adequate reserves
- Attend to the demands of governance, both locally and in a global sense

### 2.1.4 Governance

**Articles, control and takeovers** Shann Turnbull [4] in a report in a publication of the shareholders association, points out that the formal method of electing directors in nearly all Australian public companies could be seriously flawed. It permits a dictatorship by the minority and denies the ability of minority shareholders to protect themselves against the interests of a control group. As the election of directors is determined by the articles of association and these rules are prepared in response to the request of those who will be, or are, directors they may not adequately represent the protection of shareholders. There is even a bias in corporation law against shareholder's according to Turnbull, since a special resolution is required to elect each director without requiring a ballot to determine which nominees are elected first to fill any vacancy. Even the model articles of table A determine that only one third of the directors are to retire each year. By this means the board can stop opposing directors by having their own nominees stand for election first to fill all vacancies. This

weakness could throw some light on the apparent weakness of independent board members to force policy review, particularly concerning biased insider action. Directors should feel sufficiently independent to investigate any related party transactions involving members of the control group.

To make sure that all shareholders receive a fair return in the event of a takeover, it is necessary to see that the control group, as distinct from the minority shareholders, do not receive special extra benefits because of their control position. To reduce this potential for imbalance a form of preferential/cumulative voting is required according to Turnbull who points out that this is operating for all national banks in the USA. To be effective annual election of directors would be needed. In this system all votes can be placed with one director to force some minority representation on a board if this is justified.

**Dynamics of governance** Mark Blair [5] defines good governance as "essentially about putting in place appropriate controls or mechanisms to ensure that managers (defined widely to include executive directors) act efficiently and in the best interests of shareholders." In discussing dynamic governance Ian Dunlop [6] considers that there are three fundamental forces which will drive the Australian economy for the foreseeable future i.e. liberalisation, globalisation and technology. Effective governance demands a preparedness to encourage change, to experiment and be flexible. Of the dominant pressures one of major importance is the movement of superannuation reserves to provide a substantial source of investment funds and therefore power in the hands of those controlling those funds and their board representatives. Dunlop suggests that there is a move from the "trust me" to a "show me" accent applicable to boards and their directors and that it is increasingly expected that they take on the wider responsibility of environment, globalisation and consistant standards. He is disappointed that most debate is centred on conformance rather than performance improvement.

While the success of the market economy is totally dependant on the ability of companies to undertake , and profit from, prudent risk taking Dunlop considers that legislative restrictions on governance should not be allowed to undermine international competitiveness. He points

to the tendency to abrogate responsibility by buck passing decisions to industrial courts as a typical example.

Summing up, good governance is a competitive advantage and as Dunlop states:

- recognise the changing relationship between directors and share owners as a positive contributor to enhanced performance
- move corporate governance emphasis from a conformance mind-set to a balance between conformance and performance
- be structured to ensure directors contribute significant strategic perspectives, both domestic and international, to assist in determining corporate direction
- accept the need for transparency and disclosure within the constraints of genuine commercial confidentiality
- recognise the need for open and timely communication to shareholders and other stakeholders
- be proactive rather than reactive in their contribution to corporate performance

## 2.2 THE MANAGING DIRECTOR

The Managing Director (MD) or General Manager provides the link between Board policy and those who have to implement the company's marketing production and financial plans. These activities and the services which support them are the subject of later detailed chapters. This executive has, however, to translate policies into action. In many cases the Managing Director spells out to the Board proposed policies for their adoption.

### 2.2.1 Responsibilities

Whether the Managing Director is dealing with the Board or those reporting to him/her, the qualities of leadership and the ability to communicate ideas and proposals are critical to the execution of his function. Bradford and Cohen, in their book *Managing for Excellence* [7], refer to the qualities of leadership in terms of an accent on personal development in all its forms. They point to the importance of getting away from the accent on the ego of the leader and not working on a basis of fear to promote results. They talk of a shared responsibility team provided by the managing director. They place the accent on the 'Manager-as-Developer', who constructs a team that supports enough openness of communication, trust and mutual influence so that the group can assume some of the responsibilities for individual growth and development [7 p168]. This demands a great deal from the leader. As Developer he must be willing to become more vulnerable, if there is to be an open relationship with subordinates that allows all to talk about things that are interfering with performance. The risks a subordinate takes in accepting new assignments are the Manager's risks as well. These writers state 'you have to give up the mantle of heroic invincibility'[7 p.166] and continually be prepared to learn.

From a manufacturing point of view there has been an emphasis in text books on this subject written by informed academic people and perpetuated in many of the many major staff training colleges that manufacturing is only confined to the work stations of a total firm [8]. No doubt this has come about by departmentalised academic engineer writers overseas being primarily in contact directly only with the production activities of very large firms rather than contact with the total management of the firm involving its finances, marketing and board policies. In the opinion of the author this has meant a degrading of the need to understand

manufacture in a comprehensive sense. In economies similar to that of Australia, where the local markets are small relative to those in Europe, United States and Japan, it is essential that a managing director embraces both the skills of the workshop and contact with the financial world, the customers and their needs. It is the purpose of this thesis to encourage this comprehensive appreciation of manufacturing, so that engineers who have so many production skills can recognise where further information would enable them to participate in overall management to the benefit of our manufacturing concerns.

The advances in information technology and the movement of many of our firms into global markets requires that the managing director has a comprehensive knowledge of basic financial matters, as well as an outwardness which allows contact with the market place and a wide range of people who impinge upon the business. This is an integral part of general management many engineers need to incorporate in their business activities. This includes the bank manager, merchant banking house, local council, the local member, service clubs, environment groups and last but not least one's family.

One could argue that the micro-economic activities represented by running the local business is the only function of the MD, but it has become clear that leaving the effects of the macro-economic factors, represented by general wage level, interest and inflation changes, to be judged solely by the board is unwise. The MD needs to keep an eye on these questions as well as on the value of the Australian currency and the condition of the world economy.

The latter considerations give rise to the need for consideration of the span of control. Many authorities on organisation structure consider that five senior people reporting to the managing director is as many as that person can deal with efficiently. If one observes the implications of the last paragraph, a much wider span is involved than that of the formal organisation chart. When we take into account the question of personal contact with many members of the firm, as apart from the operation of the formal hierarchical structure, we see that the managing director needs to have the ability to very carefully allocate time on each of the important functions involved in guiding the business, including time to appraise his priorities. Organisations are dynamic, they change from year to year, people leave and new

appointments are made, products follow their life cycle and rise and fall in their importance. The need for departments changes as processes and sub-contracts vary. Consequently, the managing director needs to see that an effective organisation structive, defining the general areas of activity within the firm, is continually under review. Part of this organisation structure is the inclusion of feedback processes which ensure that the messages passed from the board and the responsible executives concerned receive a satisfactory response. This process applies to quality and cost control, in fact to any important decision to be implemented, and is a check on whether information services are operating correctly. The rapidly advancing message transfer processes within an organisation are becoming ever more critical to performance in the current highly competitive business environment.

When the particular engineering, financial and marketing skills are examined, it is apparent that knowledge of certain areas is critical for the managing director. These areas of importance are listed below. However it is useful as an initial observation to consider Table 1 from an article by John Kotter in the Harvard Business Review in April 1999 [9] with the title "What effective General Managers really do". The author hopes that "growing the market" in this table includes the goals for manufacturing methods and the allied technology needed to achieve market continuity and growth.

| | 0 -1 year | 1 - 5 years | 5 - 20 years |
|---|---|---|---|
| FINANCIAL | Objectives in all financial areas | Goals for sales income and return on investment | Return on investment in 10 - 20 years |
| PRODUCT & MARKET | | Goals and plans for growing the market | Vague notion |
| ORGANISATIONAL | People changes and related items | | Emphasis on type of organisation and calibre of management needed |

Table 1. John Kotter's overall view of a General Manager's principal tasks

John Kotter also refers to the general manager's network in a large company which gives an insight into the wide range of people who are important to the welfare of a large organisation :

| | |
|---|---|
| Financial services | Dozens |
| Customers, Suppliers and Competitors | 50 |
| Government, press and public | ? |
| Bosses | 10 - 20 |
| Peers | Dozens |
| Immediate subordinates | 5 - 15 |
| Subordinates of subordinates | 100's |

Some of the activities listed below are less important for particular industries , for example, for essentially commercially orientated concerns, plant technology may not be as important whereas the weekly turnover of stock may be a critical factor. Flexibility as to the areas of most importance is required. What is necessary is to review each area as the firm develops to check that new areas receive the correct emphasis for a particular enterprise. This consideration applies in particular to service areas which may be a whole department or include several functions supplied by one person or a contractor. Proliferation of departments is not the answer. If the head of a main operating department is sufficiently aware of quality needs and responsible enough and capable of absorbing quality control, for example, then place it under that person. A similar consideration applies to such needs as production planning and cost control. Have a minimum number of people reporting to an executive but cover the needs.

The relative position on the same site of departments and their supervision, planning and quality control support services can play a part in the efficiency and team work that takes place. The transmission of ideas between R & D and production staff, for example, is facilitated by placing them near each other. In an innovation group in Sydney's Redfern the facilities and offices of high tech companies, are purposely arranged with this in mind. Management spread over a wide geographic area needs special structural appointments. Interstate and even suburban production centres need to have a person nominated as

responsible for that site, its security, housekeeping and communication services. The author [10 p19] has experienced the problems arising in a textile firm with premises in Sydney, Adelaide and Melbourne with a head office in Melbourne, where the spinning, weaving and make up departments all reported independently to a corresponding leader in Melbourne. Cohesion at each site was chaotic until a single area manager was appointed at each place to facilitate local communication and administrative control. However it was found that sales and marketing policies such as pricing still needed close national coordination.

Among the most important of the items the MD/General manager should keep under review are:

### 2.2.2 Financial

An understanding is required of the calculation and implications of profit and loss, cash flow, balance sheets, funds movement and such items as gearing and liquidity ratios. There needs to be an ability to coordinate the forward planning and budgets of the company by drawing on the skills of the staff responsible for marketing, production and finance. Reports and action are needed on debtor and creditor levels and the bank position. Also involved is the need to appraise every item of major capital expenditure with a view to its return to the company in terms of its 'present worth' and 'rate of return', or ability to improve competitiveness. In addition it is necessary that the value added measures, applicable to capital and wages respectively, be kept under review. One of the assets to be nurtured is the firm's knowledge base - the skills vested in its staff's experience. Development of people as part of leadership, in the sense described in earlier paragraphs, applies to staff and board members as far as the MD's function is concerned. The duty of the accounting functions both inside and outside the firm should include comment on the firm's growth in a positive way rather than just "doing the books" . The MD should expect observations on opportunity for improvement associated with stock levels, gearing, investment needs, maintenance contribution, liquidity and cash position and benchmarking within the industry, from the accounting people. These comments are important as well as management of cost control, prediction of dividend and tax position and the implications of proposed capital expenditure together with the assumptions made in arriving at a recommended item.

Some legal knowledge is required as far as marketing and supply activities are concerned to do with contract law, formal contracts with customers and terms of trade, control of debtors and bankruptcy and supply contracts. There are also legal requirements applicable to machine purchases, leases and hire purchase, rentals and insurance. Most of these are fairly straight forward and part of normal commercial practice however the important thing is to consider carefully who you deal with and what you sign at all times. Many able business people would prefer to bypass a contract, even if it looks lucrative, with a group they believe they cannot trust or has defaulted in the past on a promise without a valid reason. Engineer managers can build up their knowledge in these areas by building sound relations with a wise solicitor, consulting him from time to time, until they feel confident about these matters. Legal advice should always be aimed at solving a problem by negotiation , not by resorting to the courts and still further legal advice. The solution should be suggested by the manager, who armed with most of the facts and a proposal, checks with the solicitor before acting, not the other way round.

By far the most important legal needs are associated with the large contract which requires a careful check and references on a client or supplier, and a major board negotiation such as a take over or merger. At board level it may be wise to have advice in company law and the meeting of statutory requirements and new legislation. Among these questions are director's rights and responsibilities, patents and brand names, major borrowing and banking conditions, superannuation and litigation matters. Legally binding contracts may need to be negotiated with senior staff involving stock options as well as salaries and fringe benefits. In the final analysis the directors are legally responsible for preservation of the assets of the company in all its forms.

### 2.2.3 Plant Processing Methods

An understanding is needed of the basic technical processes used by the company and an idea of where the potential for improvement lies. This is where the engineer as MD can play a most important part in the development of a company. This involves a detailed examination of process changes and equipment purchases at the time when they are proposed, and their

effect on the rest of the organisation The author has experienced the extraordinary success of an able engineer manager, who steered a large public company to have a strong capital base and reserves using this part of his skill, combined with his logic training, communication skills and choice of staff to complement his own training. One of the advantages of an engineering background is to be able to size up what is happening in some detail in other industries and, on an international scale, by carrying out technical appraisal visits to plants here and in other countries prior to the adoption of new processes and equipment. This skill also applies to the purchase of, or amalgamation with, another company. In the current era there appears to be an over accent on obtaining market share by company purchase, irrespective of the quality of the processes and staff liable to be acquired partly because the purchaser's knowledge of the latest technology to make that industry competitive is very limited.

Research and development (R&D) is not a remote activity to be carried out only by specialist government research laboratories and universities. Development needs to be part of a firm's culture. The process of moving from an idea through a full research cycle - from laboratory to pilot plant to batch production and finally into the market place - the safe technical route, will often leave a firm behind one's competitors in the current business climate. As explained in chapter 9, and set out in reference [10] p131, answers to ideas already carefully developed on a smaller scale than the full research cycle can receive an intermediate investment to rapidly find the needs of a later stage particularly involving performance in the market place. This is because the market development phase of introducing a new product can take as long, and be as costly, as the technical phase. This early investment to accelerate introduction of a new process or product is not a waste, or to be regarded as a mistake, but part of the need to reduce the time of the whole development process. In many cases it is at this stage that a major further investment to capitalise on the information found earlier is justified with less risk to the company than waiting for a perfect answer.

Probably the greatest benefit through carrying out internal research and development is to establish the difficulties which could be encountered with new processes or a machinery purchase. This provides the basis for sound purchasing and planning decisions and process

improvements based on adequate specifications prior to an investment. Market research projects combined with R&D can further strengthen this development process. In this respect R&D is a type of insurance policy against making poor forward planning decisions.

### 2.2.4 Production Requirements

Production leadership is effective when the customers needs are of desired quality, delivered economically and on time. From a production point of view there is therefore a need to be able to direct that certain techniques be carried out to keep production flowing and continually improve it. Such items as methods study preceded by work sampling, the review of plant layout, the selection of the site for production and the encouragement of the personal qualities required to supervise within the plant and operate its process control and planning systems are all important. Implementation of ISO9000 standards and total involvement in quality production are essential items in many manufacturing plants. In the case of a particular project the advantages of using critical path methods for the time management of the project should be understood, whether it is applied to a major construction project or the design stages in moving from a prototype to a marketable product. It is unwise in the present economic climate to wait for each part of a process to be complete before proceeding to the next item to be made. Many components need to be produced in parallel and project planning techniques applied to estimate where the bottle necks are liable to occur, and to calculate the total time expected to complete a project.

The use of automation and robotics is a matter of having a sufficient market to fill the machines involved. This has led to the consolidation of world commercial blocks, such as the European Common Market, North American Free Trade area and the Japanese/South East Asia region to establish a sufficient market size to allow automation. It has also tended to change the dependency on labour investment as distinct from capital costs in the technically more advanced countries.

Maintenance is an integral part of production - not an annoying cost. The cost of down time due to lack of production, wage costs and lack of capital recovery can be significant unless maintenance is given careful consideration. Both condition monitoring and allied preventative

maintenance methods provide a guide to the extent of maintenance activity required. The time between overhauls and replacement of vital components as required are regular activities for most plants. Recently the accent has been placed on estimating the consequences of failure to determine where the emphasis should be placed. In addition, from a financial gain point of view, maintenance is an asset preservation process and saves premature depreciation.

### 2.2.5 Computing Services

There is a need for a dispassionate view of the current information technology (IT) revolution. Involved is an appraisal of the design function in computer technology as distinct from the programmer function and the effect on the user of the software involved. It does not necessarily follow that the manager has to be able to understand in complete detail the function of the software or hardware involved. An understanding of management information systems, knowledge of how operations research can contribute to the solution of large scale business planning problems, will assist the manager. Risk taking skills is a vital part of the MD's activities. There is never a perfect solution and quite often it is necessary to make decisions with only part of the data although one would desire greater certainty. The early training in mathematical statistics provides a basis for much of the decision making which is required on a day-to-day and long term basis. There is an analogy between such mathematical distributions of information as the Normal and Poisson relationships and practical decision making associated with risk.

### 2.2.6 Marketing

Without customers there is no business. The MD, therefore, needs to spend a significant portion of his time analysing client and marketing questions, such as prices, complaints, distribution, advertising and promotion, methods, products and their design, public relations and advertising as well as assessment of orders currently held and those expected in the future. In businesses which have a high turnover of stock each month the price margins will need to be very different from those involved when a major project liable to take many months to complete is involved. Regular contact with leading clients is usually essential since the manager needs to be aware of the essentially optimistic nature of marketing staff when proposing sales figures for the company's budget. A market research project may be required

to clarify the potential for a proposed new product. Assessment can require tactful moderation of sales expected without destroying the initiative of the sales force. An important consideration is to balance the fact that the sales people need to sell the productive capacity of the plant, while on the other hand the production people need to adjust their production to suit the requirements of the customer. This is an important balancing act for the MD which has implications for both equipment purchase and working capital requirements.

### 2.2.7 Infrastructure

Of all the trends of the last two decades, the most significant change for manufacturers has been the movement towards increased infrastructure of a specialised type. The organisation chart needs continual review as people, products and departments change, and should the geographic distribution of activities be revised, area management appointments may be needed. Examples of trends are information management systems and elaborate planning procedures such as MRP, ERP [11] and Mass Customisation [12] and their need for review [13]. At the same time the rate of communication has increased substantially with mobile phones, faxes, email, video conferencing and the internet, which have altered the way in which business is being conducted both personally and on a global basis. For example, it is more convenient to conduct a video conference between automotive manufacturers and suppliers using three dimensional images as part of the discussion, provided the time scale in the world is convenient for the participants [14]. This gives a competitive advantage, for example, for Australia in dealing with parts of Asia when both groups are normally at work at the same time. Another example is the ability for senior management to travel quickly and relatively inexpensively to other companies overseas to negotiate business in person rather than completely depend on a local agent.

### 2.2.8 Personnel Policies, Integration and Democracy

There is evidence, in the author's experience, for a need to change management and structure in manufacturing industry when a buyer's market exists compared to the situation when a seller's market operates. When the Australian government was encouraging substantial wage rises and accelerated union action at a time of buoyant sales extraordinary wage rises, high inflation and large margins on costs could be charged. Vertical integration, that is, operating a

limited volume business from raw material through to finished product without sub-contracting, including an allowance for cost of living rises in one's sales prices, was one answer to survival at that time. Quoting firm prices on long term contracts was a disaster. In the current, 1999 economic climate with its low inflation, stable wage situation and a buyer's market there is a much greater emphasis on horizontal integration in which substantial sub-contracting operates. In this situation a company is advised to concentrate on the specialist activities in which it is well skilled and capitalised and looks to volume sales based on a few important processes or components to supply a whole industry. There are recent indications that these considerations could apply on a global basis as well as locally where the global market players are free to operate in an uninhibited fashion. One can only conclude that economic conditions tend to play a major part in the type of organisation structure one should adopt. Figure 3 shows these alternative structures in diagramatic form.

**STRUCTURAL INTEGRATION**

| **TYPICAL VERTICAL CASE** | **TYPICAL HORIZONTAL CASE** |
|---|---|
| Seller's Market | Buyer's Market |
| High wage rises & high inflation | Stable wages & low inflation |
| Multi skills needed | Focus on specialist skills |
| Spread, and hence higher total capital | Concentrated lower capital |
| Low volume, higher internal cost product | High volume, lower internal cost product |
| **Raw materials (RM)** | **Component & some RM purchases** |
| **I** | **I** |
| **Many processes** | **Specialist processes** |
| **I** | **I** |
| **Component assembly** | **Component assembly** |
| **I** | **I** |
| **Finished product distribution** | **Finished product distribution** |
| **I** | **I** |
| **Retail shop** | **Wholesaler** |
| **I** | |
| **Customer** | |

**Figure 3. Vertical and horizontal integration tend to be aligned with economic conditions**

For similar reasons to those outlined above, the type of management approach in some firms may need review depending on the economic conditions. In the current buyer's market where jobs are not as easy to obtain there is less demand for the heavy handed hierarchical type of manager in the normal coarse of events. (They are however being employed to drastically prune staff where an organisation has neglected its responsibility to plan properly in the past). Whatever the economic state the efficiency of participatory management though its accent on communication and motivation throughout the firm is important for all firms. In a democratic society, not controlled by particular "isms" where people are free to move from one employer to another and express their likes and dislikes there is a strong case for adoption of a participatory philosophy whatever the economic climate. Welfare departments to be fully effective should therefore be more than a library for the collection of award rates and industrial safety rules. Welfare officers should be proponents for better communication throughout the plant and encourage the development and training of all employees.

As outlined in the initial paragraphs of this chapter the manager should be a developer for all the people and facilities of the firm and this implies the need for management skill in encouraging participation, team work and feed back of ideas while still maintaining overall coordination of the board's objectives.

Sharon Beder [45] in her recent book points out that engineers need to be more vocal and more responsible in a community sense. She says "Engineers can go on being technical functionaries doing what they're told by employers. Or they can look at the political and social nature of projects and take real responsibility." "They can work to protect the environment and look at social influences on engineering product and design, not just economics." The author of this thesis believes that this same attitude can be stimulated initially by engineers being trained and encouraged to place greater emphasis on both helping to manage and managing in a comprehensive fashion including their customers, suppliers and the community associated with the organisations of which they are a part.

## 2.3 THE MARKETING MANAGER

The marketing manager's activities are considered in this chapter under the following headings:

**The importance of marketing**
**How an enterprise starts and grows**
**The marketing department and ways to compete**
**Sources of operating income**
**Supply and demand**
**Break even point and preliminary budgets**
**Advertising and public relations**

### 2.3.1. The Importance of Marketing

Marketing is a key department within a manufacturing firm and it plays a major role in its financial and production development. A marketing manager perceives and then initiates a project where there is a particular need within the community. The marketing mind discerns that there is a need for products which, if manufactured at a certain price , will provide a satisfactory return on the investment to produce them.

It should be appreciated that some marketing people do not have the skills to produce a product, or may be less aware of the financial dangers of over estimation of a market or the price attainable. However these executives invariably have a skill in personal communication with potential customers. Sales people within the marketing department can not only identify an important need but also stimulate a demand for it. While promotion, advertising, brochures and public relations can result in inquiries, the person in the front line who presents a proposal, obtains recognition for a product and its price with the customer is the sales representative. At the same time marketing staff need to be able to work with production staff to establish a cost effective design and attractive product image. Sufficient volume of sales is required to justify the heavy investment in production plant required to compete, using advanced technology, on both a local and global basis. The whole firm's budgeting needs should be fully appreciated by the marketing department, particularly profit and

liquidity requirements, and the need for practical forward sale's plans for all the firm's products.

Marketing personnel can be the initiators of a particular project. In any case they should be vitally interested, enthusiastic and emotionally involved in making a success of the marketing side of the business if that business is to succeed. The marketing staff need to be able to estimate the size of the expected market and the distribution methods best suited to the customer and the dispatch department. The nature of the competition which might be able to undercut the firm's price, quality or service should also be assessed. It is up to the sales staff to define the specifications for the products which the customers desire and assist with assessment of the price/volume relationship which is likely to apply.

Marketing is the generation of customer appetite which will provide income. It is based on the economic supply of a need. Its function is therefore to identify that need, play a part in product design and at the same time stimulate improvement in the product by encouraging the updating of the firm's production and services. Marketing is a comprehensive function, not just the work of the final sale by a sales person. The complete professional marketing approach should not be prejudged by other professions, such as engineers, as associated with sharp practice just because some dealers are less than professional in their methods. In fact to stay in business for a long time a high degree of integrity is necessary for all professions and marketing is no exception.

Some of the important management policy objectives within the marketing department are discussed in 2.3.3 below under the heading "The Marketing Department and ways to compete".

### 2.3.2 How an Enterprise Starts and Grows

It is important to be aware that although marketing is critical, a firm may start from any one of the prime areas of business activity - Marketing, Production or Finance. Within any one of these areas there can be a person or group of people who desire to implement an idea. The marketing manager's task is to locate a need in the

community. He or she sees a gap where products or services are desired or needed and can research how that need can be met at a particular price, product design, package or marketing skill.

Motivation can take the form of future profit, community interest, a belief in one's idea, an ego boost, fear of failure or simply a sense of executive responsibility. Every "idea" needs a champion to get it into the market place and this action needs to be on going if consolidation and growth is to take place.

Some business people argue that in the early stages of development it is best to avoid too radical an approach. Ideas need in general, to be at least level with, and not too far ahead, of the market for success to be achieved economically and with minimum risk. Watch also that the product will not become obsolete before sufficient recovery of the investment made to get it into production has taken place.

Design, production and customer needs must be intimately linked to achieve the highest levels of quality. The marketing department must understand the customer's business and translate this knowledge into product design parameters. Advances to product design should occur ahead of needs. As pointed out by Morino [15] quality should be built into the design, not just depend on inspection later. The production process must be capable of meeting the design specifications. Also, the product's design should facilitate ease of production and take advantage of the production systems and technologies available. Finally delivery, installation if applicable, and after sales service and support must all meet or exceed the customer's expectations.

### 2.3.3 The Marketing Department and ways to compete

#### 2.3.3.1 Summary of opportunities to compete

The marketing department needs to appreciate the many ways to compete as set out in figure 4. This modified diagram from a presentation by Porter [8], emphasises the author's view that manufacture involves the whole of the company , not just the limited area of action defined by Porter. To improve competitiveness it is necessary to carry out a business strategy which concentrates on examining each section of a business and attends to each of the items of figure 4 . At the same time balance cost,

dependability and flexibility between commercial and production decisions. Parallel with this, to meet marketing needs, the production staff need to concentrate on quality, encourage innovation and service throughout the organisation while carrying out forward capacity planning.

Two requirements for success from a marketing point of view to ensure an effective and competitive manufacturing strategy are repeatedly emphasised in the literature, that is:

- Get the right product to the right place at the right time
- Produce the products competitively by having a sound, well managed production facility.


**Figure 4 Areas of manufacturing business activity which can be a source of competitive advantage** (Modified by the author from Porter [8] to define manufacture as an overall responsibility)

### 2.3.3.2 Price and margins

**Price calculation** While particular policies may override a formal price calculation, in the majority of cases prices are determined by either the application of standard component costs or hourly rate methods followed by addition of an amount for profit. These methods are:

- Use of standard costs

  Price = Mark-up X Sum of the total costs of the components making up the product

  {The cost of each group of components = Unit cost, including direct labour, materials and overheads, X Quantity of that component in the order}

Standards in dollar terms are set for the total cost of each part of the process including labour, materials and overheads, and when multiplied by the number of components produced at each cost center are added to give a total estimated cost. This total is multiplied by a desired fractional increase , say 1.15, to provide a profit and cover contingencies, to arrive at the final price.

- Use of hourly rates plus material costs

  Price = The total of (100% + mark up %)/ 100% X Direct labour hours at each machine X Hourly rate for that machine ) plus the total of ( 100% + Handling margin %)/ 100% X Materials cost )

  {The hourly rate = (Actual labour cost per hour) X (Total of labour and overhead costs including administration) and this total is then divided by (Total labour costs)}

In this latter method an hourly rate is defined for each machine or activity area. The rate uses the actual direct hours at a machine and multiplies these hours by a rate per hour (the hourly rate) which includes not only the wage rate but also includes the effect of all the overheads which the firm expends to make that wage effective. To be strictly accurate the wages need to be the wages at the cost center and the overheads need to be the result of distributing them throughout the direct production areas in proportion to how they actually occur. Rates vary with the degree of automation in the

plant. While the typical wage rate per hour for a labour intensive activity in Australia may be $13-15 per hour, a typical local garage charges an hourly rate of $35 per hour while the highly mechanised department of an automotive manufacturer can charge of the order of $70 per hour.

Summarising this method, the hours spent at each cost center are multiplied by the hourly rate for that center and these subtotals are added for all the areas of production required to make the product. To this total is added the cost of purchased items with some allowance for handling and trading costs. To this overall total a margin for profit is then added.

**Margins** Many sales executives refer to their achievements in terms of the total dollar value of sales achieved. These figures should always be considered in the light of the contribution to overheads provided by those sales. From the sales should be deducted direct wages, materials and supplies and the balance should be sufficient to cover all the relatively fixed costs of factory and administration. If they do not provide a proper margin, the overhead recovery of the sales is unsatisfactory irrespective of numerical value.

For some firms , including single component manufacturers, but particularly retailers and wholesalers, the rate of stock turnover largely determines the profitability of the company. For this reason the rate of stock turnover, measured, for example, by the numbers of equivalent months of stock sold in the current month can be an important measurement for management by applying it to each product group. When the return on working capital is considered, for example in a case of 1.5% profit on sales, and if this capital is turned over once per month then a very satisfactory return on working capital of 18% per annum is achieved.

**Pricing policy** Pricing is not necessarily associated with cost. The price acceptable to a customer is the amount that customer will pay irrespective of the firm's costs. Pricing policies are clearly one way of stimulating the market. In accordance with the principles of supply and demand a drop in price can lead to an increase in sales in a market of high elasticity. However in a saturated market dropping the price will only

have a minor effect and radically reduce profit. The danger here is that the break even point may have risen to such a level through the price drop that production unit costs are dangerously increased. Attention to the break even chart described in section 2.3.6 below, shows how to determine the extent to which a price drop will affect results. Too often a price drop has been advocated without the necessary calculation to support the effect of the change.

The price bracket in which a product will fit into the market place usually depends on the price of a similar product from a competitor. However this is not always the case since the opposition product might be a similarly priced, but quite different commodity which is also attractive to a customer in the consumer market who only has enough cash for one choice.

Some firms employ differential pricing in which " loss leaders" are marked down to entice customers into a store and increase their other sales. What is important is to know the real margin on each product group. For this purpose, particularly in the case of a retail or wholesale outlet, it is important to calculate the real margin left when sales price has purchase costs deducted. From this margin the additional costs of handling , packing, dispatching, building area and services, wastage and loss due to damage as well as clerical and administration for each product group have to be found. Having reconciled the total of these costs with those of the company's books the profits earned by each product group can be found and action taken to correct prices, delete unprofitable products, or promote the very profitable ones.

Export pricing, described in 2.3.3.4 below, in another important approach to entering a previously untapped market. In this case overheads can be reduced when calculating a price since they are largely covered in the local sales.

### 2.3.3.3 Quality, innovation, design and marketing/production liaison

**Quality** Most people regard the quality of a product or service as being determined by the extent to which the defined needs of its users are satisfied. Top quality gives an immediate advantage to the marketing department. However the time frame over which the satisfaction is to apply is also important. Some people refer to "fitness for purpose" and "conformance to requirements" but the essential need in each case is to define purpose and requirements rather than dodge the question and claim to aim at perfection.

Review of quality achieved in the organisation as a whole initially requires concentration on the original design of the product, or a component, to check it meets the customer's approval in short and long term and can be made economically. Next there is a need for the firm's management to be structured so that, with the right people and processes, the agreed design can be consistently attained. Finally it is essential that the processes selected can achieve the necessary production tolerances and specifications. With these conditions met it is then up to the staff of the firm at all levels to ensure that the right quality is achieved.

There are many acronyms and titles applicable to the pursuit of quality to achieve the above in part or as a whole. Of these the importance of quality assurance, a procedure for continually checking that the whole of the items outlined above are in fact in place, is clearly of major importance.

The author considers that continuous improvement of quality and productivity as an important staff function is vital, rather than necessarily implement a specific more dramatic project to achieve improvement.

To achieve good design and quality is the essential ingredient which will result from close cooperation between the marketing and production departments. The marketing department because it is acutely aware of the product criteria which will meet customer expectations, and the production department since it is conscious of the processes needed, and those available, to meet a quality specification economically need to work together. The production manager would also prefer to adopt a design

and processes which allow production of products without having to rely on elaborate final testing. This may require high precision automatic equipment and very skilled people.

A management structure which facilitates the production of quality products is essential. The ISO 9000 series of quality standards sets out targets to provide this need and should be regarded in this light. Backed by top management and staff a correct framework along the lines indicated in these standards allows quality policies to operate throughout the firm. However an accreditation certificate, having been obtained in accordance with the ISO procedures, while a valuable sales asset is no guarantee to a purchaser unless it is part of an ongoing dedication to the quality objectives of the company.

The final item needed for quality production is control of process. This not only involves the attitude of all the people concerned but, in many instances, requires elaborate process measuring devices and equipment which can produce components within specified tolerances. The statistical basis for process control needs to be understood by the production staff so that the probability of a result occurring outside agreed limits is understood and receives practical consideration.

**Innovation and design, marketing/production liaison**

Irrespective of where the initiative comes from, the marketing department has to turn the advantages achieved from innovative ideas into a result for the company. Figure 5 shows the three main sources of facilities and control innovation. The production department and the overall management drive and imagination usually play a predominant part by suggesting new processes, new equipment and design changes to make production cheaper.

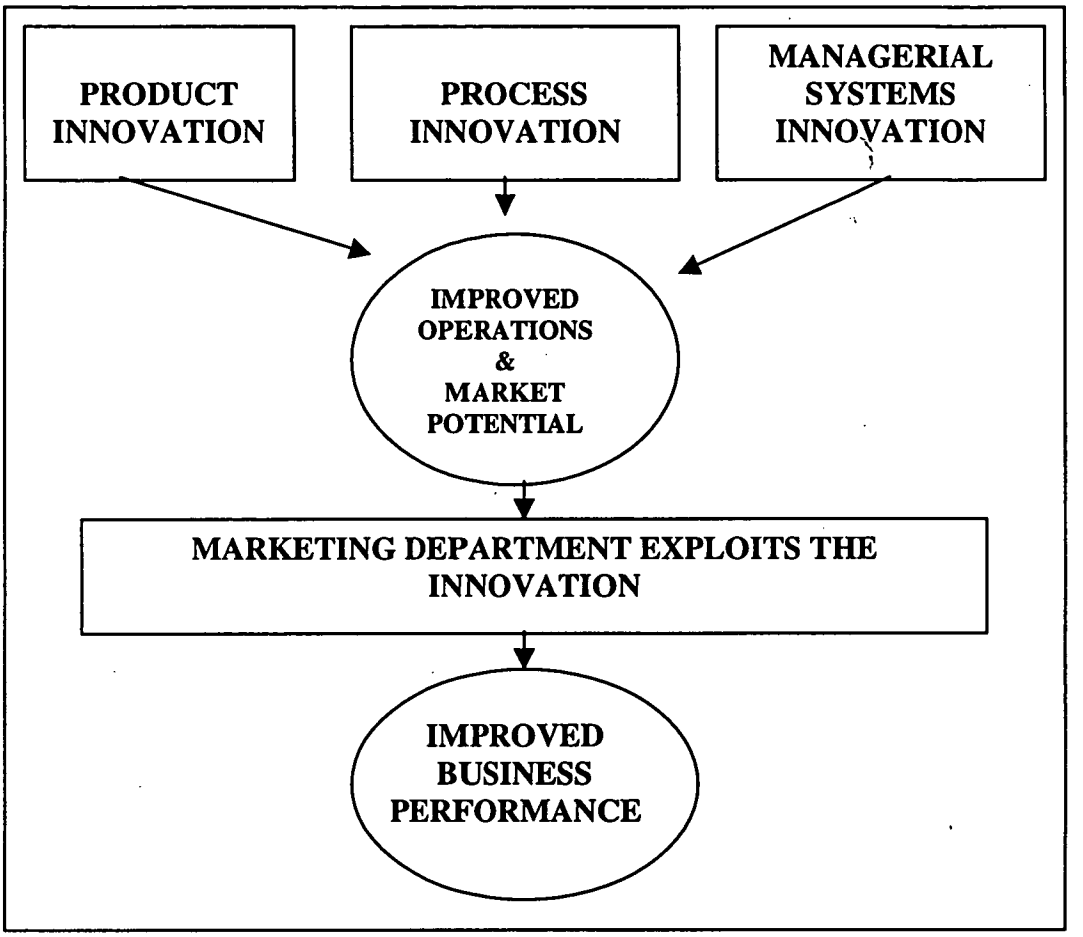



**Figure 5. An overall view of innovation**

Idea generation is critical to success of this process but without an individual pushing for that idea and being able to convince others to assist in its implementation, many a good idea languishes until sighted in an opposition product. Most innovation comes from an association of different ideas and a breakdown of divisional boundaries and new, sometimes unconventional, ways of tackling the same market, from within the firm and across the science, economic and social disciplines.

As already outlined, design is a function which requires input from both production and marketing to meet a customer's need as to function, life and product image. It has primarily to be judged by the sales staff but the product has to be made by economic processes in the plant. The product has to be designed to involve the fewest number, and easiest manufactured parts for the plant to manufacture it at a competitive cost.

The marketing staff have to help by liaison with customers to obtain acceptance of this practical design.

#### 2.3.3.4 Market share, patents, licenses and trade marks

**Market share** At present one popular method of ensuring sufficient profitable sales, if sufficient capital is available, is to acquire the whole or part of the public company capital serving a major part of an industry. By this means a greater market share is obtained and price competition is substantially reduced. The marketing department can point in the direction of the products which could be subject to this approach and the price structure liable to prevail when the higher market share is obtained, but it is primarily a board matter for implementation. A variation on this action is to produce closely similar products under different brand names and promote each through advertising. The inherent life cycle of all products makes it important that the take over target's products will last long enough in the market for the heavy investment to be recovered. The danger in this procedure is that complacency in service and internal investment can take place within a firm's marketing and production departments due to the drop in competition. Some firms in Australia have adopted this take over philosophy and found that their management has lost the initiative, innovation and aggression so important for long term survival. On the world's stage it is possible to have companies whose total capital, market share and financial strength is greater than that of a whole nation so that local legislation can be impotent as far as financial control is concerned in these cases. Legislation in Australia aimed at trying to keep a market share situation developing into a monopoly is in place but fragile.

**Export pricing** International markets and automated production facilities require that a pricing policy be established based on the fact that any market which would not normally be obtained can be of advantage provided the price covers the material plus the labour together with only a portion of the overhead and administration expenses , not the total overheads, since they are already covered by the local market. This opportunity should however not be abused or international tensions affecting other markets will take place due to claims of dumping and unfair competition by those in the region receiving the goods.

**Patents, licenses and trade marks** These commercial agreements are designed to provide an advantage to the company as a result of the company's investment in developing an idea to the point of its incorporation as a unique product, process or title in the market place. The patent, being a precise description of a newly discovered process, is registered with the patents office after thorough checking of the fact that it is in fact original. Its claims are carefully set down by this process. The origin of patenting was to encourage progress by providing a way for a researcher to recover the investment incurred in the development of the new process. It also has the mixed blessing of telling the world about the invention ! There are also those who use this procedure in reverse, that is they carry out research on their raw materials and patent their findings to prevent their key suppliers charging too much for their raw material supplies.

Licenses are provided as a right to use a patented or similar specialised process and recover the benefit of that skill through fees. One type of licensing is a franchise which refers to payment for the right to use a set of agreed specifications to guide the operator and a common trading title which may be promoted on behalf of all the participants by the controller of the franchise as part of the principal's obligations.

A trade mark is a way of branding a product or package to create a continuous identity for that product in the mind of consumers. It is a costly process to establish a brand name through advertising, packaging and sales representation. To provide stability in this situation and prevent opposition companies copying that brand name, to unfairly acquire its reputation and gain the benefit of its special attributes, the trade mark is registered for a fee with the register of trade marks and upon acceptance provides protection against copying for a period into the future.

#### 2.3.3.5 Globalisation, automation and robotics

**Globalisation** The principal forces behind globalisation of advanced industrial activity appear to be the extraordinary improvement in communication between all parts of the world combined with the need to search for, and capitalise on, external mass markets to feed highly automated production facilities.

Electronic transfer of messages and funds are now occurring on a 24 hour basis around the world. Company staff can have an international conference within a few hours complete with screen presentation to discuss a manufacturing need such as a marketing , production or financial question. Aircraft can take staff to a meeting on the opposite side of the world over the week end, at a cost of only a few week's wages. The contrast between high capital and low capital availability, high wage and low wage employees, high technology and low technology knowledge throughout the world combined with this communications revolution is promoting large scale capital and production facility movements between countries. These differences have the potential to be broken down by globalisation but from a marketing angle caution is required particularly as to culture differences, resentment of control and unfair establishment agreements. The principal error revealed in recent years is providing capital too readily and without an understanding of the trust and business culture of both lender and borrower as well as funds not being tied to practical implementation plans. The infrastructure of the country, its legal, political and religious culture need to be taken into account when contemplating investment overseas.

The message for the market department is to go and see, do not just appoint an agent and hope. Frequent visits and establishment of a joint venture with a trustworthy company in which mutual trust and respect has been developed is an initial requirement. Submissions to a Pacific region automotive conference in mid-1999 by the leaders of the automotive societies of the region reported on the advantages and disadvantages of globalisation to their countries.[16]. In China's case there are indications that automotive product development ability has been greatly strengthened particularly through joint ventures and the learning of advanced technology. However the deputy secretary general did point out that the initiative to create their own brand car tended to be limited and the rate of entry of new information was hard to digest. He also indicated that so many more cars were being produced that a buyer's market now existed, in other words the number of people with the income level needed to pay for a car was less than potential production. The Indonesian SAE President pointed to an emphasis on assembling cars close to the customer to keep the product in line with regional tastes and give attention to product diversity. The Japanese President indicated that a wider choice was now available to their consumers because of

globalisation, both as to parts and complete cars. He stated that benefits included increased production volumes and an evening out of local fluctuations in its economy through being strong international competitors. On the negative side he drew attention to the difficulty of complying with the different regulations which apply around the world and the need for us all to work for unification of manufacturing standards. Another item raised was the need to share the latest technical information on an international scale. The language barrier with non English speaking countries was a barrier to communications. The Japanese welcome technical information transfer opportunities at conferences and are clearly in favour of globalisation. The Korean President accented the purpose of globalisation as a question of economy of scale, cost cutting and the need to complement local weaknesses. For Korea the advantages are the provision of state of the art technology, quality parts and diversity of input and commends the reduction of trade blocks and barriers. He quoted experts as believing that if car companies failed to plan, build and market cars and trucks on a global basis they will be relegated to second class status and he quoted the observation that combination will reduce the number of major manufacturers to only 6 by 2010. Problems encountered have been cultural differences and the tendency of a company which lacks technology, finance and capacity to be a subsidiary rather than a partner in an alliance. When local R&D engineers and quality spare parts are not available progress can be limited in some countries. A warning on the financial side is that the cost of setting up a car plant is predicted by one manufacturer to fall to as low as one tenth of current costs in future leading to a drop in car costs to one half of current cost. On the down side is an over capacity prediction for the industry as a whole, within ten years by 20 million vehicles per year ! The Thai Vice President came right down to earth. Following commendation of the advantages of trends towards harmonisation of world standards and more business opportunities, more foreign investment and the benefit of quality parts he detailed some deep concerns such as : the Auto giants dictate the terms both as to technologies and markets; regional bases by the larger firms are to allow competition between the giants; Thailand are to abolish their import restrictions and duties revenue by 2000 with the net result that some ASEAN industries will have higher production costs. In conclusion the Thai speaker stated that "the rich shall be richer" and cooperation requires "fair mutual benefits" with a

recommendation that globalisation should include in its objectives learning to live together in harmony as well as gaining short term trade advantages.

One can only conclude that globalisation and the level playing field needs to be approached from a marketing standpoint as a question of market size, technology exchange and investment into a culture one understands and can work with. At the same time we should not leave our industries vulnerable to overseas controlled groups and countries not necessarily playing by the same level playing field rules that we have adopted.

**Automation and robotics** to understand this subject in any depth, one has to recognise that engineers have moved from a world of bearings, tolerances, stresses, fluid flow etc. to a business area subject to the pressures of marketing on an international scale. Technology and management are rapidly changing and this now means that the organisation structure of our businesses must encompass very close marketing/production liaison, systems, delegation, investment and financial control as well as traditional engineering. Figure 6 illustrates the joint activities required to operate a manufacturing business within an automated economy.

Automation involves having a sufficient size of market to justify the capital expenditure involved and a source of capital to allow the investment needed. To meet this need, world groupings are taking place on a scale never seen before. When we consider the purchasing power of the population of the European Common Market of more than 300 millions, the North American Free Trade Area with a grouping of more than 270 million people, and the Pacific area involving Australia and Japan and a portion of the South East Asean countries with purchasing populations of well over 270 million , we see enormous economic pressure on automation investment. Added to this are the further potential of Chinese, Indian and Russian markets with populations of over 700, 550 and 240 millions respectively. [17]. But there is a political catch. If the purchasing power based on the standard of living in a country is insufficient for them to pay for another country's manufactured goods, the number of people in a market can give a false impression of the size of a market.

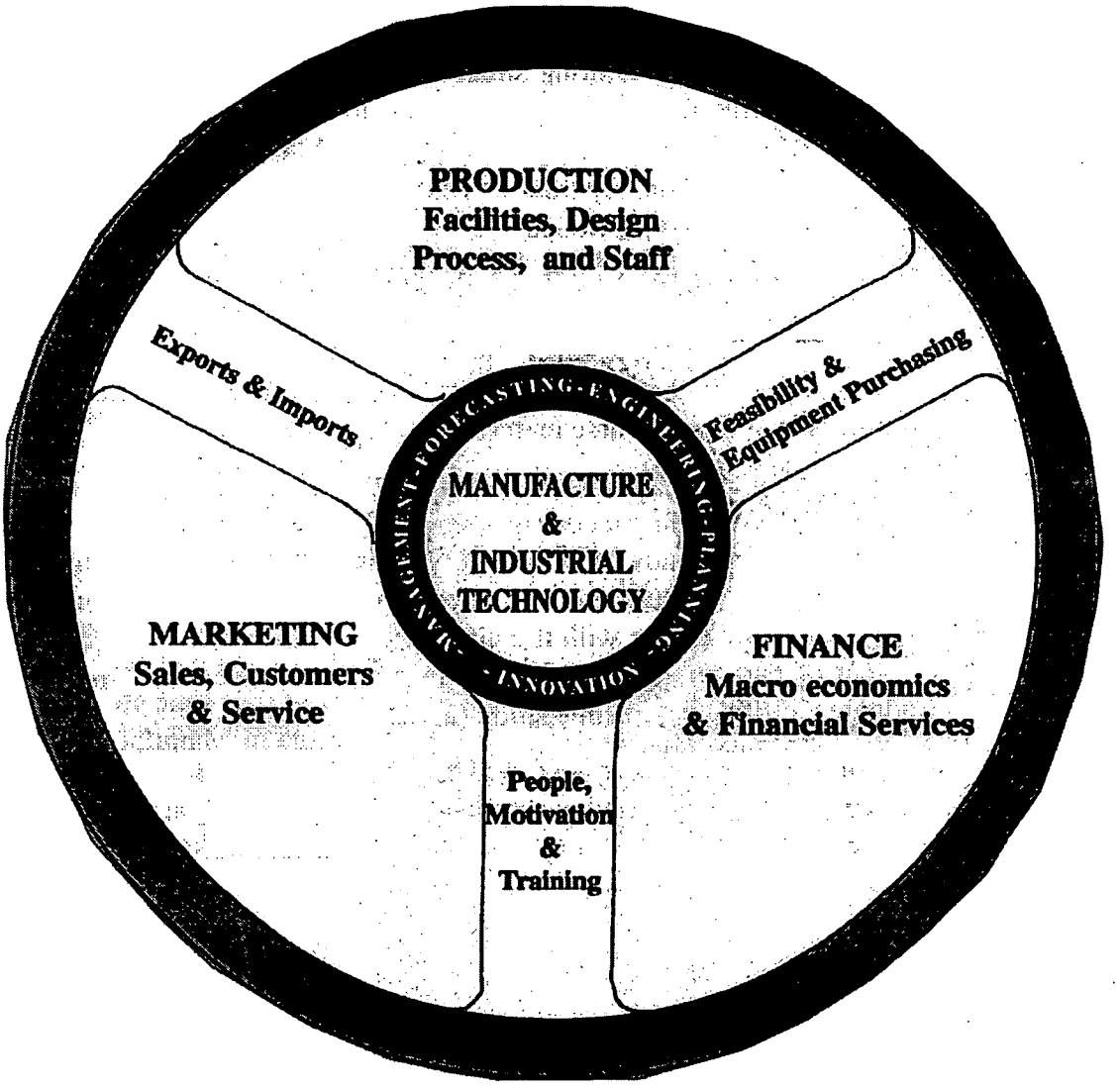



**Figure 6. Chart showing the principal departmental functions within a manufacturing firm working within an automated economy.**

Another important factor is that freer trade and capital movement has led to many firms with highly automated equipment relying on sub-contracts for their components, the components being supplied from any country in the world. This is clearly the case in the automotive industry where there is an intense accent on "outsourcing" contracts from another country to meet the needs of centralised assembly plants.

On a more local basis there is always the balance to be drawn between labour and capital costs. In Australia for example, a machine investment of around $100,000 as

capital on a 5 year life machine is approximately equivalent to the cost of one person as far as wages for the shop floor and office of around $25,000 per annum are concerned. As marketing and general management labour costs can be up to 3 times this amount per annum. these figures show that the latter people are even more vulnerable to replacement by infrastructure capital. This plays a major part in the continuing confrontation between capital and labour.

In terms of Australian investment in computer numerically controlled machines, the current estimate is 7000 machines increasing with imports at about 500 per year. [18] The next stage of machine development, the robot, is a further challenge to production management but its justification is again tied to the size of the market. A robot can work 24 hours per day with no health worries, wont answer back and requires very little manual labour. The cost of a complete robotic set up and its programming is substantial and far in excess of its preliminary hardware investment depending on the number of axes employed [19]. Among the investment costs in addition to the basic unit cost of up to $150,000 are such items as mounting, safety devices, peripherals, programming for each application, preparation of the site, commissioning and line balancing for multiple operations which may add a further $50,000. Current robots number around 2500 in Australia. Finally, we have the case of even more elaborate systems involving groups of robotic cells needing integration and elaborate feed back systems involving computer linked sensors.

#### 2.3.3.6 Service and distribution

**Service** Service refers here to the attitude towards customer and supplier needs. From a customer's point of view a reputation for providing service is a most important part of a sales person's armour in approaching a customer for a purchase. Later on, service can play a vital role in whether the customer stays with a company.

Service is generated by all members of a company. From phone answering and assistance at despatch to the interest shown by the board members in a customer's welfare, the action of all the company's staff play a part in developing goodwill from customers and the community in which it operates. The hard core of service is the response to customer's needs, delivery on time, attention to last minute changes in a

specification or order, prompt response to queries on quality and price. Finally sometimes service involves just spending a little time to solve the other person's problem.

**Distribution** While this can be a production or a marketing responsibility, the decision here is whether to sub-contract this work or use in-house vehicles and staff for this purpose. This decision usually depends on the value of the productive time of an in-house employee compared with the cost of a contract delivery and the benefits of driver contact with customers.

### 2.3.4 Sources of Operating Income

A check list of income sources which can result from a marketing department follows. These items are listed to provide a reminder for follow up on each and check that adequate cash flow occurs from those sources the company has chosen for its sales. In total the contribution by marketing is the operating profit. The cash flow contribution they make is the profit plus depreciation although the latter is deducted as a cost in the accounts. There can, of course, be cash effects caused by other departments due to such items as capital outlays, changes in loans and changes in the terms of trade. Briefly these sources are:

* Cash sales. In this case goods are paid as they are delivered.
* Credit sales. Payments for goods sold on credit may be received, for example 6 weeks after the goods have been delivered and then invoiced to the customer. A major portion of manufacturing and supplier sales in Australia are on this credit basis.
* Payment for goods sold overseas. In this case exchange rates apply and can vary from day to day. The currency to apply should be defined eg. $US or $Aust. in the original quotation. The money is usually sent as a cheque or bank draft payable at a particular bank in Australia. The funds are deducted at the customer's bank overseas when the draft is prepared and the goods are made available when the customer's bank cheque is received here.
* Payment for services. These are usually paid after receiving an invoice since it is not usually known what charges apply until the services are carried out.

* Dividends or interest on outside investment. Returns from investments, such as term loans to others or shares, are paid at intervals such as twice per year. Returns may be fixed as a percentage of a loan or debenture, or variable depending on the profits and dividend policy of the investment's managers. Some dividends are franked, that is, they have some tax already deducted on behalf of the investor with that amount credited to their tax account with the tax department.
* Interest on internal company cash reserves. This item refers to the returns from the internal reserves and credit accounts of the company, including interest from deposits in the short term money market.
* Capital gain. This return is the result of selling an asset at a higher price than the depreciated value of the asset in the books of the company. This can apply to a machine, a building, or a vehicle. The cash flow effect is however the total cash received.
* Rentals and lease payments. These amounts apply to company premises used by others, often paid one month in advance with rate charges for water, waste and council services applicable to the occupied premises. The term of the lease and options for the future are defined in the lease agreement.
* Commission on sales. These are usually paid as a percentage of the value of all items sold for another company, or on a piece rate basis for each sale achieved.
* Return of deposits or debtor amounts. These are amounts due to the company which have previously been written off as bad debts. In this case these amounts become a contribution to income.
* Discounts for volume purchases. These are discounts recovered from bulk purchases but not previously taken off the accounts rendered. The discount may be , for instance, based on annual purchases after a year has elapsed.

### 2.3.5 Supply and Demand

**Supply and demand, marginal revenue and marginal cost** The question of whether a product will provide a profit when sold in the market place at a particular price depends on the extent to which that price exceeds the cost of production. However since the cost of making the product varies depending on the demand for

that product in the market place, that is, the need for that purchase. Hence the ability to obtain a profit from it, will depend in turn on the demand in the community at the price presented.

It is therefore advisable to consider the laws of supply and demand which affect estimates of cost and price for every product. Typical supply and demand curves are illustrated in figure 7.

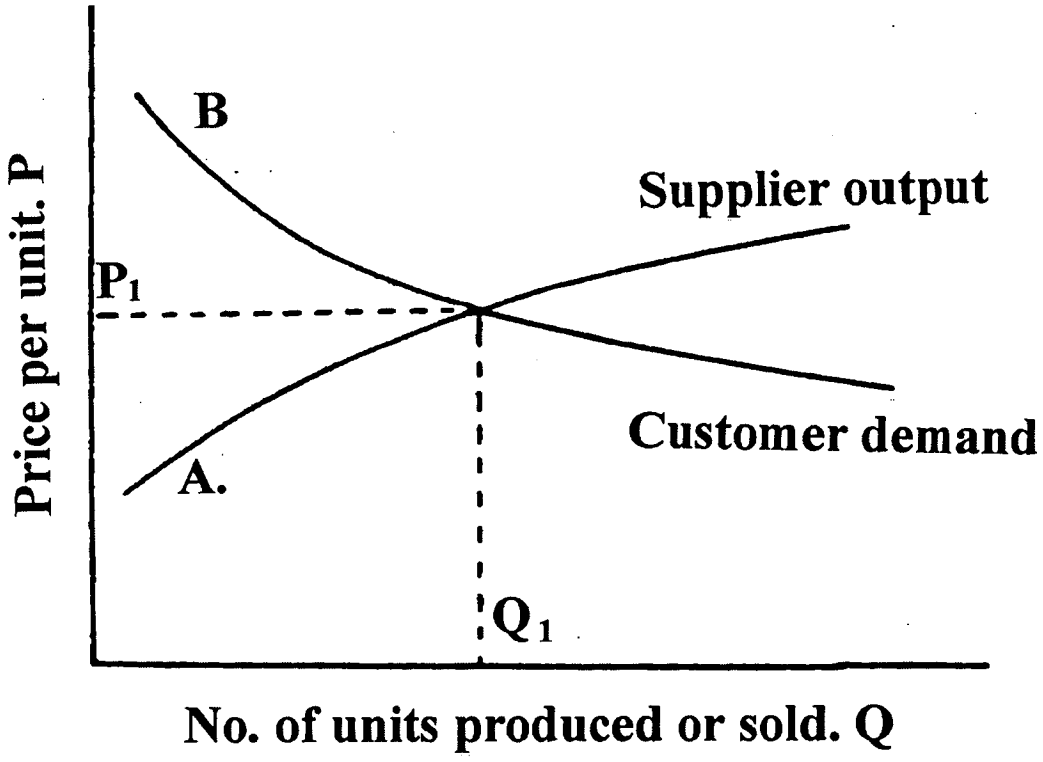



**Figure 7. Supplier output and customer demand curves**

The supplier output curve "A" represents the quantity of the product a manufacturer will offer for sale as the price obtainable in the market for that product increases. The customer demand curve shows the quantity of that product that people are willing to buy as the price of that product falls. The intersection of these curves determines the price at which exchange between manufacturer and customer takes place. The quantity exchanged is then equal for supply and demand. In the illustration the number of units that will be exchanged is "$Q_1$" and the price at that point of exchange is "$P_1$".

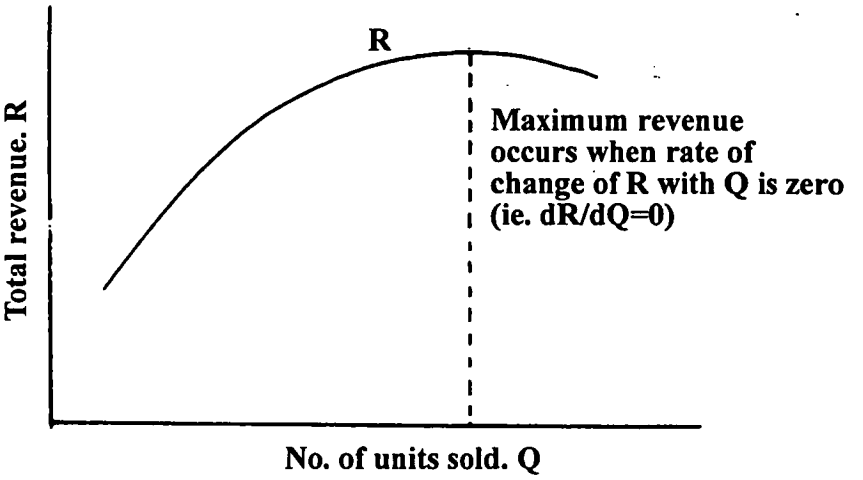



**Figure 8. Total revenue curve as production quantity changes**

Figure 8 shows a graph of total revenue "R" against the number of units sold "Q" at price "P", where R=P X Q. Note that there is a maximum total revenue after which the market becomes saturated. At the point of maximum revenue the rate of change of R with Q is zero.

The marginal revenue "Mr" graphed in figure 9 is that revenue derived by further sales of one more unit,. i.e. the income from "n" units minus the income from "n-1" units. This marginal revenue needs to be compared with the marginal cost "Mc" to test whether higher production will yield higher profit. Should "Mc" exceed "Mr" then there is no further profit advantage in increasing production beyond this point. When Mc =Mr the best profit position has been reached.

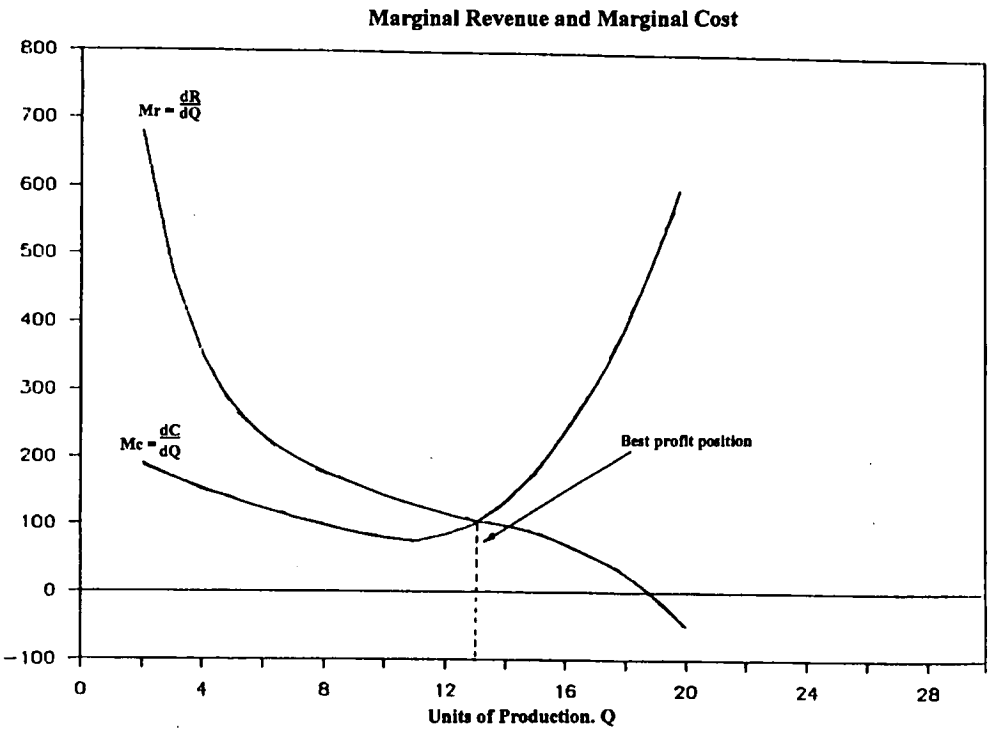



**Figure 9. Graphs of marginal revenue and marginal cost**

These supply and demand curves vary between industries. (Economists refer to price elasticity to describe this situation. High elasticity occurs when there is a large change in demand for a product when price drops a relatively small amount expressed as a percentage of that price. Unit elasticity occurs when a drop in price results in a corresponding rise in demand. Inelastic demand is such that there is only minor change in demand when the price drops.) By graphing the average cost curve "Ac" ,figure 10, using cost "C" divided by the number of products "Q" we can obtain the point of lowest average cost.

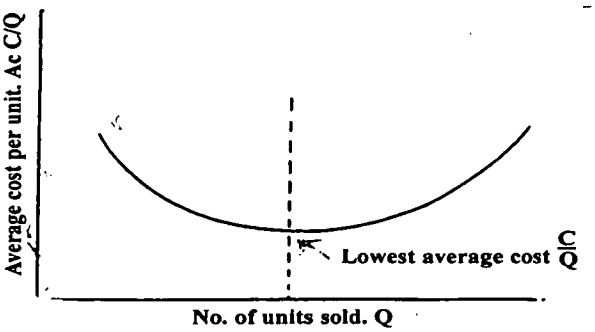



Figure 10. Graph showing variation of average cost with production

Figure 11 shows the point where Mc = Mr the point of production above which the cost of producing an extra item exceeds the revenue from the sale of that extra item, i.e. the best profit position. While the value of maximum profit and hence the point of best production can be estimated by finding the maximum difference between total income and total cost , it is generally more accurate to use the graphs of figure 11 which combines curves for "Mr", "Mc", price "P" and average cost "Ac". To do this, project vertically from the "Mr" = Mc" point to the price and average cost lines to obtain the unit cost at this optimum point. The area of the shaded rectangle is then the best profit obtainable. Note that the best profit position does not coincide with the minimum average cost position.

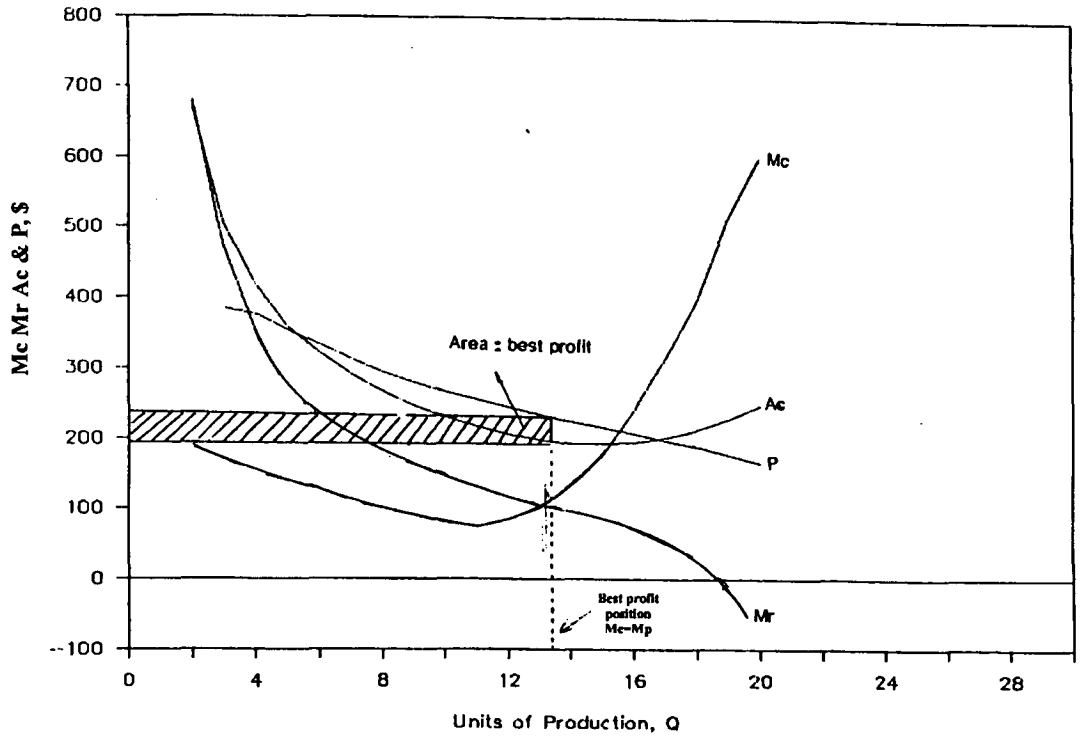



Figure 11. These graphs show a calculation method for obtaining the value of best profit

### 2.3.6 Break even Point and Preliminary Budgets

Analogous to some extent with the supply and demand analysis, break even point is the determination of the point where the level of sales income and cost of production are equal as shown in figure 12. At this point the total cost equals the total income. Above this level sales become profitable. Below this level of sales losses will occur. Break even points are a way of assessing whether sales are sufficient for the particular production facility or alternatively whether costs should be reduced to be in line with

income. Budgeted profit should be above the break even point. Calculations using the break even chart can be a useful method of determining the effect of a drop in price on the increase in production required to compensate for it.

The more expenses are variable with volume, in this case the total costs are low for low production, the smaller the effect of volume above break even point in improving profit and the greater the danger of exaggerating the effect of a price drop. Alternatively when the total cost line on the chart is almost horizontal sales above break even are usually very rewarding.

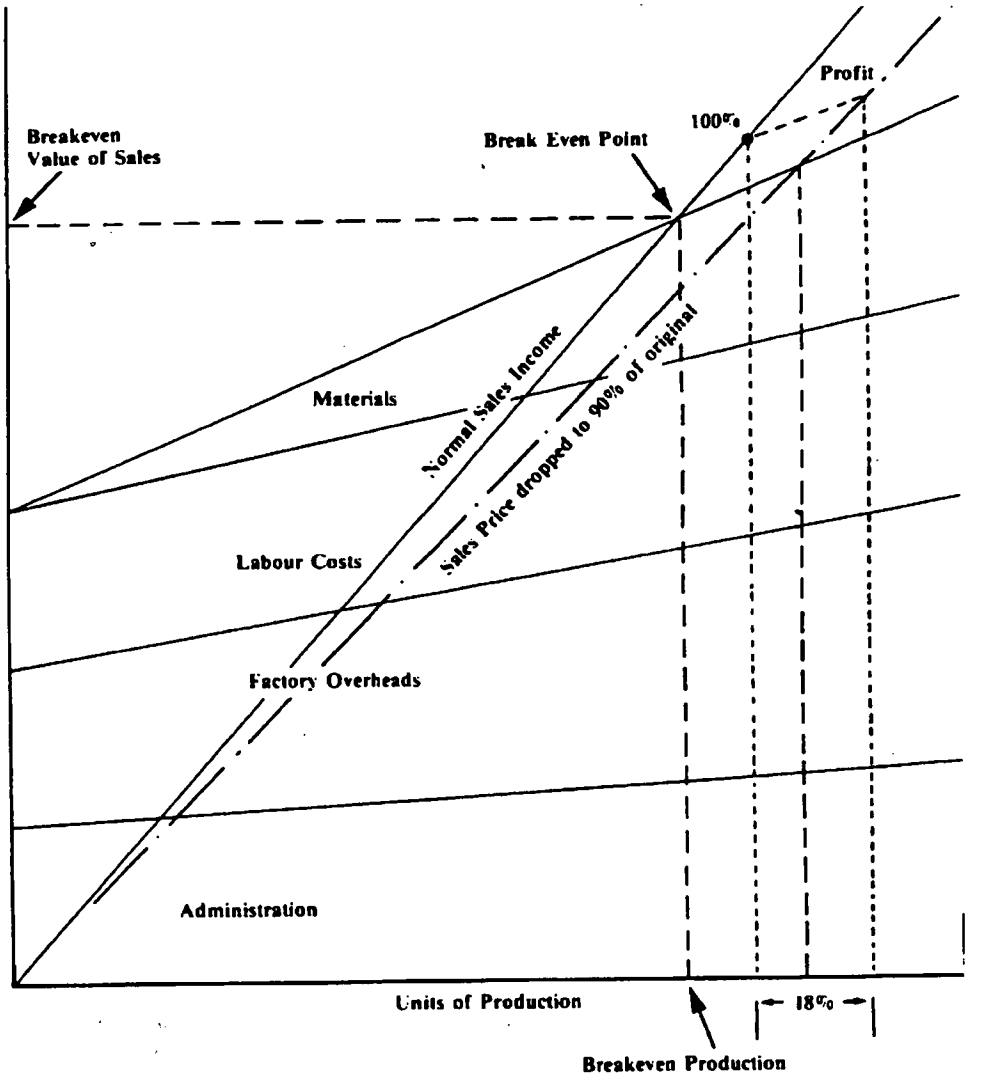



**Figure 12. Break even chart showing the minimum production and sales required after which income will exceed expenses. In this example to support a 10% price drop the sales and hence production will have to increase by 18% to achieve the same profit.**

### 2.3.7 Advertising and Public Relations

**Advertising** The background to advertising and its benefits [28] are:

- Buyer attitudes affect one's share of the market
- Buyer attitudes are affected by sales calls and advertising.
- The maximum effect on buyer attitudes is achieved by sales calls and advertising working together.
- This combined effect tends to reduce selling costs and increase sales per call.
- Planned business publication advertising is a profitable investment when working with products or services involving a specialised technical field.

There are a range of advertising needs. The principal ones are corporate or image, new product, established product and a combination of these. To define the target requires a definition of product range, the price, and the method of sales and distribution. It should be recognised that technical personnel are influenced substantially by technical reputation so that image advertising is very important for technical products.

In this case the cost of a salesperson's call can be well over $50 per call. It costs less than a dollar for each hit produced by an advertisement to make the call fully effective. There is a time factor in reputation and some continuity is required to maintain a satisfactory image. Analysis of the degree of association of a particular brand with past activity may be the target. It should be clear as to whether a direct response is expected or the message is a passive one.

Understanding the buying process is a necessary part of preparing an advertisement. The "buyer" may be part of senior management or an adviser with engineering skill available and not necessarily the person who writes out the order. The buyer and members of senior management may not have the same view of who is the most important person in the buying decision and this needs to be recognised in preparing the advertisement and making the sales calls. Generally those in the middle and lower positions in the hierarchy of the firm require the most detail about a technically sophisticated product and have a strong influence on the purchasing decision. In any case the aim of advertising is to get on the short list of the tendering process in most cases and for this reason continuity of advertising is necessary despite economic booms and busts.

Advertising has more to do with tactics than strategy. Tactics involves how to achieve a target, how to improve a situation , how to improve quality and how to obtain more profitable sales. Claims of a 5 - 10% increase in sales per sales call through advertising were made in a New Scientist survey. This raises the question of which media to use, television, newspaper, specialist magazines or direct mail. The emphasis for the first of these is on consumer goods in which many thousands of people are contacted, whereas in the last two methods the aim is a specific highly specialised buyer.

**Public relations** Many companies appoint a public relations agent to prepare and distribute to media outlets news letters telling of the company's new products, new staff and policies. These are often arranged to promote an idea in such a way that the journalist in the media company can insert the item in a newspaper or magazine without further need for editing and so save time and effort before publication.

## 2.4 THE PRODUCTION MANAGER

A production department is responsible, now and in the future, for the output of required products to satisfy customers, economically, on time and within the available financial resources of the firm.

This is a department with which engineers are familiar as far as process, infrastructure and technology are concerned. It is proposed therefore to concentrate on aspects of the department's operation concerned with its management, drawing attention to matters, although familiar to most engineers justify a reminder of their importance to the functioning of the firm as a whole. Whether any of the services described in this work are organised under the control of this or an allied department depends on the magnitude of that service and the aptitude of a particular department's staff to supervise that function. The purpose of this chapter is to define those activities and facilities which are generally needed to make a production department efficient in both short and long term, irrespective of where they are placed within an organisation. These needs are considered under the following headings:

* **Defining the products and scope of production.**
* **Design and purchase of facilities**
* **Sub-contracts and materials purchases and obtaining funds**
* **Design of infrastructure**
* **Supervision and motivation**
* **Updating, Review and use of Industrial Engineering**

### 2.4.1 Defining the Products and Scope of Production

The products, in general, are based on the need that has been ascertained by the marketing department through personal contact with customers or by market research. As part of this process, it is necessary to rationalise several criteria. First there is a need to decide on the range of products which can be economically produced by the production department. To base production on a customised product, involving a wide range of alternative items, will lead to a more complex production system and a different business structure from that when mass produced items of similar dimensions are being produced. Again, there is the need to consider the total product's design in relation to the processes which are available to make the

product. Since the skill involved in making some components is not available in-house and the capital required for some processes on a limited volume of production is too high, it may be wise to sub-contract some components of the product. It may be possible to reduce the number of components or processes by redesigning the product. A particular process may dictate that one of the components making up the product should be similar for each item in the range. Design requirements may also affect the costs of a sub-contractor or supplier. This need for redesign may require that the supplier's point of view be obtained prior to finalising that supplier's contract. This can apply to the materials used as well as the method of manufacture by the supplier.

The total of similar orders that can be expected from the customers, particularly from a global point of view, [17] in relation to automation and robotics policy, will dictate the degree of automation and extent of shift operation which can be applied to the production process. All of these items require careful analysis and co-operation between the marketing department representing the customers, the production people of one's plant and the production staff of the suppliers. These design considerations need then to be combined with the advice of the 'image' design people and the advertising groups to decide on the methods of packing and presentation. A prototype may be necessary to test the customer's reaction to the proposed design and check the proposed methods of manufacture using CADCAM.

Another factor now receiving attention from large manufacturers is the selection of materials and processes which allow recycling of the product or component and recovery to reduce raw material costs. An example is the recycling of car bumper bars by Honda [20], using plastic materials, and employing infrastructure to collect and even reprocess the bumper bars to overcome impurities inculcated in the original processes. Honda now processes over 600 tonnes of plastic bumper bars per year in Japan in this way.

It is fundamental to the work of the production department that it aims to meet what the market needs, even though heavier investment than that initially thought necessary to process particular new products may be involved. In a similar manner as explained in chapter 2.3.1, it is necessary for the marketing department to encourage customers to accept output, as far as

possible, which can be economically made using the facilities of the production department. Both departments depend on each other. Morino [15] of Toyota, points to the barrier created by lack of cooperation between departments such as marketing, production and suppliers as one of the weaknesses to be overcome in manufacturing concerns. He considers "Total Simultaneous Management" is vital for future automobile manufacturers, not only to reduce both cost and lead time, but also to establish a friendship network towards boundary-free, borderless management. Morino accents the fact that the keyword "Communication" is not the means of information transportation in itself, the means is the result of heart and mind transportation. He sums this up as " The fusion of intelligence and emotion under a motivated strategy is the key issue". Comments on simultaneous engineering and factory innovation accentuate that customers now demand top quality. This requires an overcoming of departmental authority barriers including those with our suppliers. His criteria includes giving factory know-how instructions to the designer, to build quality from the start, not by inspection later. He indicates a preference for replacing "knack" and skill by high precision automated equipment in addition to generally raising the levels of responsibility and personal skills.

### 2.4.2 Design and Purchase of Facilities

#### 2.4.2.1 The investment decision

When considering the investment decision, one is driven to the conclusion that many Australian enterprise activities have to face the fact that in many cases proven equipment purchases from overseas is justified. Equipment may be available complete with proven marketing data applicable to a ready made market in Australia. In this case a company can capture a market faster than it is possible for a local engineer executive to design, manufacture and test the equipment and market the product produced effectively.

Personal experience of the importance of making a world wide analysis of capital expenditure choices before making the final decisions have been in the electronic/mechanical field, in food processing, in the chemical industry and in printing and publishing. In one case, the prepress equipment for the printing industry sighted initally in Melbourne was around two

years behind the equipment sighted in London. A short time afterwards in Chicago still more up to date equipment was available from a branch of the same international firm as that in London. The latest, some four years ahead of the local product was available at a lower price, shipped out from Chicago, irrespective of all the agents including those in Australia representing the same supplier. Despite this experience there is in most countries cooperation and interest in supplying an efficient process and piece of equipment. In these cases every help will be given to visitors by enabling plants to be visited in which the equipment is operating effectively, and where the service attitude of the firm supplying the equipment can be gauged directly by word of mouth from users.

#### 2.4.2.2 Research and development

One of the principal advantages of research and development is a reduction of the time taken to achieve an effective place in the market. This time factor has been so critical during the nineties that every consideration must be given to procedures which reduce this time in future. The faster the process of delivery of a product into the market, following the decision to commission a new product, the greater the margin which can be obtained to recover the investment in the product's development and allow production and market penetration. Notes on risk taking and the benefits of R&D in this respect are included in chapter 2.9.

#### 2.4.2.3 Detailed design of the plant

Whether we consider the design of the product in general terms or in detail, it is now necessary to consider the processes which will be required to make the components and assemble the product. From a flow chart of the proposed process one can isolate each materials handling transfer system [21], plant item, direct labour and dispatch method which will be used within the plant. If the volume is high, one or a number of production line facilities may be implemented.[22]. It is wrong to necessarily put every component or product on a production line. A sundries production facility may be required to complement the main production lines to accommodate a varied order position. Where the size of an order for optimum performance on the production line is greater than the order actually received from a customer, many firms resort to placing a substantial internal production order on the line and then place the excess over immediate customer orders into stock. In some firms the

accumulation of this stock leads to a substantial depletion of working capital. In this case it has often been found practical to employ a group technology arrangement, in which a group of machines required to produce short runs of a particular component, may be situated together in the plant. At the same time multi-skilled people making that particular range of components can operate this group technology cell with pride in completing a whole product within their group. They have the working flexibility and knowledge of alternative dies and settings to produce short run orders of the components so that stock does not have to be held in the store on the same scale. Also the team work required in the group cell can contribute to high morale amongst those involved.

In selecting the processes to be used in a particular plant, it is important to check that each process is compatible with the preceding and follow on processes in the plant and the material being processed. A mistake which has been made in some plants is to adopt the best process on a world scale for each process without being fully aware that the raw materials were different in each case, and then finding later that the processes are not compatible when using a common raw material. Here the engineering skill involved is of primary importance, the nature of the electronics, the electrical circuits, the logic and thoroughness of the manual of operation, the spares - bearings and belts, motors and contacts required for example all need to be defined before a purchase is made.

The arrangement of the facilities needs examination to check that the relationships between the positions of each item will lead to both efficient production between work stations and communications with service staff and supervisors. Initial flow process diagrams and methods studies will assist in examining layout proposals or when considering an alteration to an existing plant. Where complex interactions between production and services occur the use of more sophisticated layout procedures may be justified to check proposals. Examples are the use of computer assessment and genetic algorithms to find optimum layout positions for each department. A plant layout is dynamic and should be designed so that equipment can be rearranged as processes change.

### 2.4.2.4 Economic factors and plant purchase

As a background to plant purchasing criteria and R&D assistance provided before purchasing of company requirements a knowledge of the micro and macro economic climate in which the firm operates is essential. [23].

The micro-economic climate in which a company operates includes local wage level regulations and actual wages paid as well as labour availability, local accounting and legal practice, knowledge of current technology and business management, supplier policies and terms of trade. There is also the need to know the market in which the company's products are used, including the extent to which the market is satisfied and the price structure which applies.

The macro-economic factors which can affect company decisions are such items as interest policies liable to be controlled by the government through its central bank, arbitrary depreciation allowances to promote investment and the extent of overseas investment in Australia. Other factors are international tension, the value of our currency as judged by the world's financial markets, the degree of protection for one's industry, environment protection attitudes and the history of manufacture in Australia.

International trade, both dumping here and the opening up of markets in another country, with the help of an importer in that country can, as in the past, be affected by a range of pressures. Military power or local culture can play a part, or as has often been demonstrated, specialised knowledge, technology and advanced products combined with financial strength can be the predominant factors. An accumulation of capital in a country, for short or long term investment, is another consideration. In the latter case money can move locally or overseas over night between stock exchanges as opportunities arise, causing major fluctuations in local financial standards and currencies.

Tariffs and bounties have been used to assist local businesses to work within our wage structure and market size, against the pressures of international competition. A balance needs to be preserved between protection , allowing preservation of key skills and industries on the

one hand, and feather bedding on the other. The latter leads to lack of vitality, low productivity and a false estimation of our own worth and competitiveness in world markets. The problem here is that, in both local and international businesses, if dumping or undercutting takes place long enough by a well cashed up predator the opposition collapses and the resultant monopoly allows the predator to raise prices to quickly recover past losses, reduce local skills and control the market.

#### 2.4.2.5 Financial justification for facilities purchases

Careful analysis of every piece of capital expenditure, in particular when substantial amounts or vital processes are involved, can be a way an executive, particularly an engineer, can contribute to the long-term health and competitiveness of an organisation. [24] By analysis is meant examination of the purpose, justification and technology of the purchases, as well as the follow up to see that the equipment is used effectively relative to the original plan developed before it was purchased. Of paramount importance is the need to check that the overall process design, of which the equipment is a part, is effective.

To ensure an accent on the wisdom of each item of capital expenditure and its effective use, a sanction form is advisable, documenting the purpose, reasons for purchase, a current and proposed results comparison, board criteria on percentage return required, timing and liquidity considerations and follow up dates. Comments on competitors' decisions in similar areas of activity are also important and implications for allied processes, sales and financial executives should be defined.

There should be credit for an executive who puts up practical ideas to the board, as against sitting on the fence to avoid making mistakes or presenting frivolous proposals. The timing of the presentation of a proposal is important to avoid conflict with a potential liquidity weakness or implications or other major policy considerations currently under review.

Research and development activity, knowledge of the industry involved and overseas inspections can all contribute to minimising the cost of a new project, irrespective of whether that project is designed and developed within the firm, or purchased from a supplier.

Four main methods of assessment used to justify a capital expenditure purchase are explained below. A wide range of versions of these can be observed in the literature. Many of these versions in economics text books are based on a crystal ball approach to accounting, in which so many predictions of the future are integrated into the solutions that the answers are only theoretical.

However, a valuable guide can be obtained by initially using the pay back method and then using the present worth and rate of return methods, both the latter being based on discounted cash flow calculations. It is also useful to check the total depreciation liable to be accumulated in a current year compared with that in past years to check the effect of investment on working capital. The principal methods used are therefore:

* Pay back method
* Present worth method, "PW"
* Rate of Return method, "ROR"
* Depreciation comparison method

Examining these in turn:

**Payback method**

In the pay back method the total cost of the capital investment is first determined – as with all methods. It is important that all costs associated with the initial capital investment are taken into account, not only the nominal cost of the machine. The cost of an extension to the premises to house the machine, the cost of electrical or plumbing connections, the cost of materials and wages used to install and commission the machine, should all be taken into account in the capital cost.

Next the typical savings per year, after taking both interest and depreciation into account, needs to be determined over, say, the coming three years. The savings are usually the difference between the expected cost of the new process and the old process. In this method, expected inflation rate, interest rate and wage level changes are considered using fairly short term practical estimates.

This method then takes the total capital cost and divides it by the expected average annual savings over the next say three years to give the number of years to recover the original investment. Typical of the recovery time expected for plant during the 90's has been three years. Hand tools at work stations usually recover their costs over only a few months. Up to 10 years is desired for buildings. 70 years was planned for the Snowy Mountains Hydro and Irrigation scheme. In the pay back method, it is important not to underestimate the capital cost and then divide this by an over optimistic estimate of annual savings involved. The net effect of using this latter data would be to show a faster recovery than that which will actually take place. The first year for example has no savings at the time of installation with, hopefully a full rate of savings being achieved by the end of the year. Despite this the method is very useful and a survey [48] carried out under the guidance of the author has shown it is widely used. Many text books wrongly leave out depreciation and are then rightly critical of its results. Calculations to justify purchase of electronic equipment in the current "obsolescence" era without taking depreciation into account would clearly be unwise.

**Present worth method**

In this method an assessment is made of the present value of future savings and eventual partial asset recovery of an investment as against the cost of that investment now. If the calculation gives a plus, the investment may be worthwhile, depending on the extent of this net present worth and liquidity affects of the purchase.

If the equivalent interest is (Int. – Inf.), where Int. is the interest rate estimated to apply at that time and Inf. is the inflation rate at the same time (as percentages), then the discounted savings from the first year are given by:

First year savings /{1 + (Int. – Inf.)/100}

The Present Worth (PW) = - Capital cost + First year savings / {1 + (Int. – Inf.)/100} + Second year savings / {1 + (Int. – Inf.)/100} squared, plus third year savings treated in the same way with the denominator cubed and so on, plus final recovery discounted in a similar manner, depending on the year of final disposal.

**Rate of return method**

If the board of the company declares that it wishes to receive more than Int.= x % return on an investment, then it is possible to insert into the above equation a Present Worth of $0 and solve for "Int.". If "Int." turns out to be greater than x% the project then gets board approval, again provided liquidity considerations allow this.

**Depreciation investment**

Some firms simply reinvest the total of their taxable depreciation for the year, choosing the best potential purchases within the limits of this figure. Certainly this is a guide which prevents under or over investment which could either, leave the firm under capitalised, or cut liquidity to a dangerous level. A wise plan is to consider each purchase on its merits, using the other methods to complement your decision.

For an investment involving many thousands of dollars, discounted cash flow methods are advisable as a check, if only to force careful and full appraisal of a project before a decision is made.

The implementation stage of a purchase is vital to the success of that purchase and should not only be planned carefully at the time the decisions surrounding the purchase are developed, but be carefully supervised to achieve the expected benefits after the installation.

Using a sanction form is recommended for all capital expenditure submissions prior to approval. Plant purchase proposals need to be documented for the board to authorise the expenditure and define how the funds are to be raised. Follow up later to check the performance of the investment is an important task for the managing director and this process should be triggered by the sanction form.

### 2.4.2.6 Acquisition of buildings

While three decades ago buildings were purchased or built on a large block of land, with long term expansion in mind, it is now financially wiser to consider facilities which meet the need plus say 20% reserve. If the return to be expected from manufacture is reasonable, most firms

consider they are in the manufacturing business and that is where their skills lie, rather than in an often speculative negatively geared property and land business. For this reason they would prefer to lease their premises on say a 5 year basis with an option to continue for a further 5 years. This preserves working capital, and allows greater freedom in new plant investment and market development decisions.

#### 2.4.2.7 Acquisition of staff

The selection and appointment of each member of the production staff is a major consideration for the production manager. It receives detailed comment in chapter 2.11. It is necessary to define the job to be carried out in terms of a job description which includes both the person to whom the person reports and the future opportunities for the employee. The appointment needs to take into account not only the particular skill required but the ability of the person to work with others and develop within the environment of the firm. The psychological pattern within the department, its weaknesses and strengths, need to be taken into account in making each new appointment. The ability to persevere, take responsibility and work with others is as important as a particular technical attribute the prospective employee might have.

Hiring of people is probably the most important purchase one can make. The minimum current cost to a firm for a full time employee is around thirty thousand dollars per year when supervision and overheads are taken into account. Some interviewers use sets of tests based on psychological characteristics to assess the aptitude of potential employees for a particular position. As explained in chapter 2.11 typical characteristics identified as important in most of us have been identified by psychologists [26]. Understanding these can be a substantial help in working with others, in supervision and in staff selection.

### 2.4.3 Sub-contracts and Materials Purchases and Obtaining Funds

#### 2.4.3.1 Raw materials and sub-contracts

The cost of purchased parts can be a very significant part of total cost. In many comprehensive manufacturing operations in Australia purchases account for more than 50%

of variable cost, whereas labour and the variable portion of overhead can be as low as 10-15%.[23] Clearly time spent on getting sub-contracting in perspective is time well spent.

The sourcing decision is whether to buy or carry out the work within the company. This applies to services or components and may relate to design, manufacturing process, maintenance or administration and apply to part, or a whole, of these activities. Take for example the case of design. The firm can set up its own studio in-house with design staff and all necessary aids such as CAD software. Another alternative is to hire contract labour to work in your studio, or have someone set up a contract studio in your plant. A total sub-contract would be to contract the job right out of the plant to a turn key design house. In establishing a sub-contracting policy it is necessary to consider a number of factors including the following:

- Company focus. Consider what is the core business and the firm's strategic direction.
- Flexibility
- Expertise and specialties within the firm
- Complexity of the manufacturing processes and the industry involved
- Unification under a single management of facilities, processes and patents
- Benchmarking to produce competitive cost comparisons
- Cost and comparison of in-house costs with those of suppliers. Consider return on investment
- Timing
- Space

With these factors in mind the patterns of current practice should be reviewed. Before obtaining detailed outside proposals decide on the best method to perform the prescribed task. Business experience of recent years has shown the dangers of being over ambitious and over exposed to economic change. It is more important than ever that a firm plans for the future and one way of improving efficiencies and return on investment is to sub-contract wisely.

As a firm grows it needs to ensure that its suppliers also grow - in capacity, quality, cost improvement, innovation and flexibility. To achieve this requires good communication, a

sense of interrelated commitment or even a business partnership, as well as a clear statement of expectations. If a company is to continue to be competitive then its suppliers also need to be competitive. This applies to both local and overseas markets.

The process of sub-contracting initially involves preparation of an enquiry package. First we need to ensure that not only do we know what we want, but see that our potential suppliers know this also to avoid distortion of a special advantage position or suspicion of a hidden agenda in the specification of the tendering process. We must ensure that an enquiry package includes an explanation of the nature of the service, the volume involved and extent of the contract, as well as the specification and terms of trade expected. The opportunity for further work should also be defined. In some parts of the automotive industry clauses are included dictating an automatic price drop after the contract has operated for a period, say a year. This whole document may be referred to as a bid package - a request to quote.

In some instances the initiating department will identify recommended sources, however if this list is restrictive then it is desirable that internal procedures apply so that the departmental head has to justify a limited approach. The justification needs to be clean cut and in sufficient detail so that it can be reviewed by the board of directors or the external auditors. The bid package as described should be forwarded to the purchasing officer for action. In addition the initiating executive should nominate his estimated cost so that the buyer can include this in his own internal guidelines for approval, such as number of quotes obtained, price and bid procedures employed.

When considering potential sources of supply the initiator should document the contents he has included - for example, the company agent, wholesaler, or principal, the extent of involvement - describe the budget enquiry and design team involvement, the receipt of an unsolicited quote; and, the nature of the business relationship envisaged. The range of examples reported in the documents could cover a full service supplier; a design, development and manufacture contract and a supply to specification case.

Purchasing procedures are critical to long term respect for the ethics and business practice of the purchaser. It is important that procedures for sealed bids, selective rebids, and splitting of contracts be clearly established prior to embarking on this type of action.

The buyer on receiving the bid package needs to consider how this submission aligns with company objectives. The terms of supplier development, joint ventures, whether systems are involved as distinct from components, and any long term agreements and productivity clauses all need to be taken into account. In the event of doubt the buyer will clarify an item promptly with the initiating department, and then proceed with any further enquiries.

Having received the quotations by the due date, the buyer prepares a summary of quotes for review by the initiating department. No contact should be made with the potential suppliers without direct participation of the buyer, and deviation from his recommendation should only be considered after senior management assessment of the justification for variation. This latter review information should also be retained in the purchasing records. Following supplier selection the buyer raises a purchase order which is the legal commitment to buy, and includes all the essential details covering the contract.

Summing up, the preparation of sub-contracting documents and the conduct associated with them is time consuming and exacting. This care and the quality demonstrated has a positive impact on a company's image. Preparing a quotation is also sometimes a lengthy process. It is important therefore that quotations should not be used for benchmarking alone, unless the supplier is in the picture. If the debate is clearly a "make" or "buy" question, the internal quote should be submitted with the external quotations at the time of appraisal. In this latter case the purchasing company's accounting staff should take part in the evaluation process.

Deming [27], the American statistical and management method specialist who was successful in Japan advocated a policy of working with one's suppliers, not just buying on price and promoting an atmosphere of playing off suppliers. The need is to develop the relationship and trust and be able to discuss problems of mutual importance without prejudice to either party. Some businesses even decide to invest in their suppliers where the supplier has special skills.

The philosophy of "Just in Time", which can be part of the contract agreement, involves reducing stocks by having suppliers who respond promptly to an order and this has major implications for the financial burden of working capital in stocks. This plan is also of importance to the system of production control adopted and the degree of participation it promotes in the buyer's plant. However some reserve has to be exercised if reliance depends on immediate delivery, as this can be affected by delays in wharf clearances and strikes when the economic climate allows this.

### 2.4.3.2 Obtaining funds

Funds may be internally generated from profit, depreciation and shareholder's loans or shares. However need for development, keeping up with competitors, technological advance and the pressures of expansion to meet market demand can individually, or collectively, lead to the need for funds in excess of shareholder's resources. There are of course cases where a shortage of capital is blamed for a firm's troubles when the real reason is the extent of past losses and the need to stop the haemorrhaging of the company as well as attend to its liquidity. Another reason for extra funds is, as explained in the comments on private companies, is when the proprietor's loans and share funds are locked up in stocks and equipment and not available for withdrawal when a personal need arises.

Banks usually provide the first opportunity to obtain funds. Banks prefer to lend against security provided by real estate. In the case of a private company the banks desire to cancel the immunity of the directors from liability by insisting on guarantees from the directors and mortgages on the director's house and/or shares. The principal lending by the bank,, referred to as accommodation, is in the form of an overdraft available on a short term basis or in the form of a term loan, i.e. a loan over a fixed period. Some minor overdraft can be available on the basis of guarantees alone but security is required in practically all substantial cases. The overdraft facilities are generally capable of being cancelled at the bank's discretion. Banks are loath to lend against the assets of the company at competitive rates but they have services at a higher interest rate for the purchase of machinery on the basis of guarantees. Lease deals are also available for plant purchases from some banks and merchant financiers also at a much higher rate. In the experience of the author the banks have changed their administrative emphasis towards their clients in recent years. They are now working more by standard

remotely set rules, rather than through the opinion of a local bank manager's assessment of a company, its past record or the calibre of its staff.

Typical rates at 1999 levels are 7% for housing, 11% for a limited overdraft and the equivalent of 16% for machine finance, a lease deal or a personal loan. These rates vary with inflation and the availability of funds that lenders provide to the bank. The nation's reserve bank tends to control the basic interest depending on both international and local economic conditions and our national need to borrow to replace national debts being rolled over instead of being paid out. Danger occurs when the banks over lend against client's assets, particularly property, which if it declines in value during a depression leaves the bank without sufficient security and this not only causes foreclosures but leads to further general economic downturn and affects all businesses. Currently at least one bank is lending to housing borrowers on only a 5% down payment on a house by a borrower. This figure was approximately 40% only a few years ago following a previous collapse due to irrational lending. Many large public companies have currently borrowed as much as 45% of their total assets and this seems too high. 25% borrowing (gearing) seems far more sensible.

Insurance groups, currently cashed up due to laws forcing all companies to put aside funds to protect the retirement of their wage earners, are interested in providing term loans to a company and at the same time obtaining insurance contracts from the company. Many solicitors are willing to negotiate mortgages for their clients. These funds are primarily for domestic or commercial buildings.

Another source of funds is through the help of a supplier who benefits from a company's sales, particularly at the development stage for a company. This can be arranged by negotiating extended terms of trade for supplies, for example, 120 day payments for supplies rather than 30 days.

Factoring is a facility offered by some finance providers. This is a system of prompt payment by surrendering all invoices to a factorer , who usually has a lien on all assets, immediately they are raised. The factorer pays a proportion of the invoices straight away and charges an

accounting/administrative fee as well. Real interest charges are usually very high to the point of danger and when combined with clauses which allow temporarily unpaid accounts to be suddenly deducted and leave the manufacturer without any wages, this procedure is not recommended. It is close to usury in many cases.

Another method of increasing liquidity is to offer a discount for a bulk sale of slow moving stock. as an occasional procedure this is satisfactory, particularly for perishable or seasonal products. However as a routine to obtain prompt payment it can erode any margin attainable. For example the loss of annual income through giving a 5% real discount on all debtor accounts in a manufacturing concern when the rate of order turn over is high, say once per month, can far exceed any normal profit attainable and lead in the end to bankruptcy. ( This is not of course the same case as that of a retailer providing a discount on a previously inflated price or a loss leader)

Whatever the source in the above cases there needs to be a business plan, and a cash flow projection to show how the loan can be repaid. Convincing the lender that the company can manage effectively and has the ability and integrity to carry out the proposed business plan requires careful preparation as well as preparedness to provide security to the lender. The bank will, in the author's experience, like to grasp everything available in the form of property mortgages and guarantees, so that the company and its directors have to decide which cover it is prepared to provide. It is unwise to submit all of one's assets as security, and as a consequence have no reserves for a contingency such as a debate with the bank at a later date.

### 2.4.4 Design of Infrastructure

**Organisation charts and job descriptions.** Organisation charts are dynamic. They change as products, processes and the people occupying positions change. While we have set out in this thesis specific departments associated with either direct activity or services to support those activities, the particular support activities may be in any one of the departments. In general, the more compact the department, the better the communication and the more effective the support services. The principal reason for having the support services separate from an

operating department, when this is of merit, are twofold. First the manager of the department has to sufficiently believe in the importance of that support service. A typical example is that of moving quality control to a separate department so that the general manager can have direct access to this function to ensure it takes place in accordance with a policy of the board. The second reason is where the function is very complex and could distract from the work of a department or is outside the skill of those in a department. Associated with this are cases where the support service is needed by several departments. A typical example is that of computer hardware and software information services which are needed in production, in marketing, in finance and in the library.

In a democratic society people are volunteers in their workplaces and participation is a vital part of motivation and hence efficiency for the firm. To encourage communication the number of layers in the hierarchical structure need to be minimised. The general manager may have five or six people reporting directly, together with a multitude of contacts inside and outside the firm requiring attention, as part of that position. In contrast to this, a leading hand can directly supervise the work of fifteen to twenty operatives in a textile firm, all carrying out the same work on the same type of equipment and he can still act as a supply and dispatch person for his team. It is useful, when considering this question of organisation charts, to refer to figures 1 and 2 in this respect to appreciate the potential for change in structure, depending on the firm's needs. What is important is that all the needs are covered somewhere, to a lesser or greater extent, as required in each case.

In firms where small independent project groups are encouraged in addition to the normal hierarchical structure, a chart of these activities could show participation by people in a range of departments. An example of this procedure, outlined by Boyles [29] is a small group, for example, consisting of one person from despatch, one from the machine room, one from quality control and a person from the office, all trying to solve a problem at a group technology centre in the factory. This procedure encourages teamwork and brings a fresh look to the solution of a particular problem. Boyles presented figure 13 which shows a secondary organisation chart to achieve this teamwork objective throughout the firm. The supervisors become the assistants to the group, and pursue the ideas until action is achieved, rather than

control them. The supervisors encourage action, based on the ideas from the group, wherever practical, and assist with authorisation of any capital expenditure required.

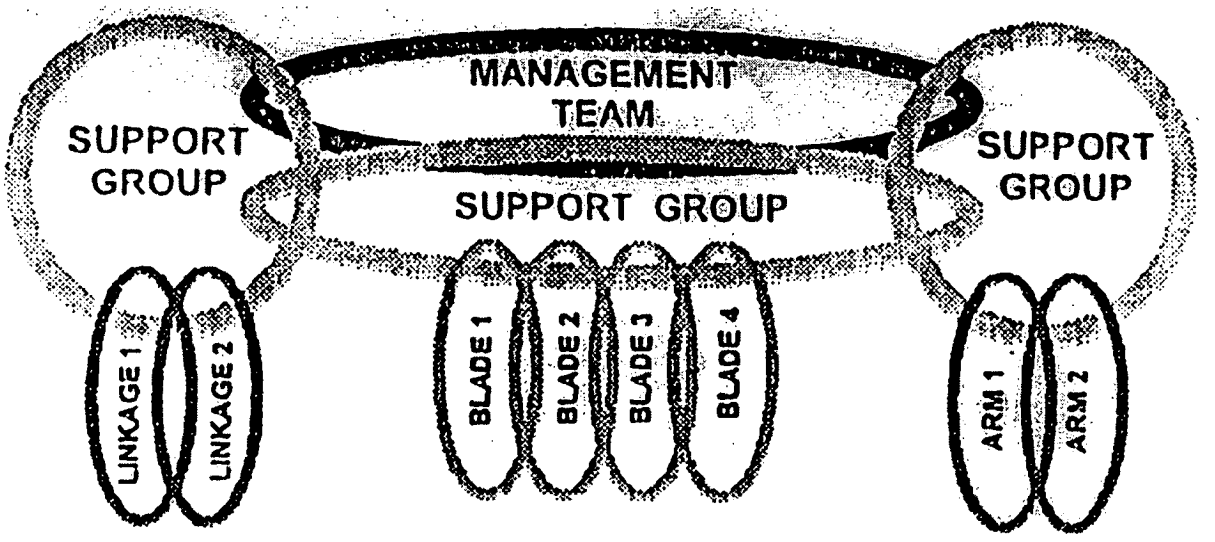



**Figure 13. The Trico team activity plan involves links between Production and a team management Resource Group using an intermediate Support Group..**

The organisation charts for companies which are widely geographically spread need attention to ensure there is cohesion and responsibility at each site. One of the staff members at the site needs to be a manager, responsible for that area, its maintenance, security and the building, for example. Sales can operate over a wide geographic area, but fragmentation of production departments at each site, reporting to a remote central control person is rarely satisfactory. The local executives need to be cohesive and capable of working within comprehensive budgets. This has been a problem across Australian states with their widely spread state capitals and decentralised major mining activities.

The organisation chart for the production department should include an allocation of responsibility for all the direct operating staff, together with production planning, costing, quality and maintenance and clarify who is responsible for sub-contract control, storage and despatch. While flexibility, defined as ability to perform alternative functions, is important, it is wise to have job descriptions of each of the major functions within production. For example, it may be necessary to define within the methods of production part of a process which improves the quality, yet costs more because the process will take longer. In this case

the process and the training of the staff needs to include this consideration to overcome the temptation to cut the cost by leaving out this additional part of the process.

**Industrial engineering** Industrial engineering skills may be vested in the people responsible for supervising the plant or be seconded from a service department as required. This important improvement process applies to the layout of the plant, to the balancing of the production lines and the effectiveness of the services to assist the production manager. Standards based on measured times and costs for each of the processes required to make up the components produced are needed. The design of the final products and their components need review on a regular basis by asking why that component is needed and applying the allied industrial engineering questions as to its method of manufacture and the processes involved. The standards for each component enable the productivity and performance of the department to be measured each day, each week and annually and at the same time provide a basis for valid costing of the total product for the marketing department. Where methods study is continually used to improve production, consciousness of this process in all staff throughout the department leads to continual improvement. When this occurs financial incentives based on piece rates are rarely economic and can lead to lack of team work in a department. Methods are continually changing and improving in a dynamic well run department. Piece rates can, however, be used for high production of a common task where high labour content and low automation apply, combined with well disciplined and scrupulously fair time study methods. Again, the benefit of the methods study is not only to find a better method and an expected time for production. It provides a detailed job description to assist in communication and demarcation. It is possible, using methods study, to rearrange a set of tasks to produce a more harmonious basis for production. An example is where specialist oilers, cleaners and despatchers are employed, instead of people engaged in all these tasks as a responsibility for the person at each machine.

**Supply of information.** The production manager needs to have an input of data and information, not only to operate the production department, but to be able to communicate regularly with sales, financial people and suppliers. As emphasised in the description of marketing department activities, it is essential that the liaison between production and

marketing departments is strong and continuing. This need to work together starts with the design of a new product. Product design affects both the customer and the production department who have to make the product. In this way it affects both income and costs. As pointed out by Morino [15] this liaison, combined with working with your supplier, will be critical to survival in this coming era. He states that quality needs to be built into the original design, not be the result of extensive inspection later in the plant. He stresses the need for reduction in the barrier between departments created by their authority and the ego of their staff. Sometimes this separateness is due to the way the authority system of the organisation is perceived by its senior management.

As already pointed out, many firms have as much as 50% of their income dependent upon the supply of components through sub-contractors. Again we see the need for very close relationships between the production department and its suppliers. These relationships require more than carefully drafted agreements with carefully worded legal clauses; they require a real desire by the individuals concerned to work together and this needs to be inculcated right through a department in its dealings with other departments. As an example, one of the problems in small firms is the attitude towards the office by the production department as being 'just an overhead' instead of being equal participants in the total process of manufacture.

Information required within the production department includes the following:

* Numerical value of production and comparison with budget
* Dollar value of production
* Dollar value of wages
* Current rate of labour turnover
* Ratio of material costs to total cost of production
* Total stocks held and exceptions to planned amounts
* Margin being achieved on the cost standards
* Hourly rates applicable to production centres and comparison with bench mark cases

* Complaints report and a measure of quality performance
* Productivity of labour and capital as a value-added calculation [30]
* Forward orders held by the company
* Capital expenditure so far this year and comparison with depreciation charged to date
* Training budget expenditure so far
* Up-to-date list of outstanding questions to be resolved and plans to be investigated.

Many of these items will have been examined in the past, and standards established, so that comparisons can be made when the reports are received. In addition the production manager should be in the picture as to the total performance of the company, to both assist his peers and the general manager to achieve the board's targets for the company and for the development of the production manager's potential to take further responsibility.

**Production planning** Production planning is required to coordinate the need for and introduction of outside supplies, the loading of particular machines and the loading of staff responsible for producing the components. In the smaller firms a Gantt chart procedure, combined with an allocation for each day of the coming period, usually on a first come first serve basis, can suffice for planning. However, as the number of parts and the size of the orders increases, the production planning process becomes more complex. For a start, some items might need to be produced well before others as different lead times might apply to the delivery of supplies and manufacture of components. Batch production may dictate a different approach than continuous line production. It may be possible to combine some of the advantages of assembly line production by applying production line methods to an apparently diverse range of final products by breaking the product down into a limited number of components which can be put together in various ways. Currently, in the market place, there is MRP materials resource planning, MRP11 manufacturing resource planning and ERP enterprise resource planning [18],[31]. There has been a realisation that this type of planning cannot be fully effective if it concentrates only on the production department. It needs an input from the policy decisions of the enterprise as a whole. The author advocates the use of a comprehensive approach to this need as set out in chapter 2.7 and detailed in chapter 4, describing a budget support system which is a simulation of the whole firm's financial and

production transactions. This approach has been developed to overcome the limitation in policy input which applies to many production planning procedures at present. It is the initial planning which integrates the whole of the firm's activities which can be the weak link in an otherwise very detailed and costly planning system. At the same time there is the added benefit of staff participation in preparing a master planning approach for the whole company. This participation makes for cohesive management of an enterprise and greater drive to achieve the firm's objectives.

**Quality control** There are two main requirements to producing a quality product. First the need for process and technology which is fully effective and designed to meet the quality standard required. In Morino's paper [15] the ultimate aim was to reduce the effect of personal frailties and replace them with fully automated equipment in which the required tolerances will be achieved continuously. To be able to invest to this extent requires very substantial markets and a global approach to achieving this.

The second need is that quality requires the effort of each person in the whole firm, from the board to the despatch section. As already explained, quality is not perfection. It depends upon the needs of the customer in both short and long term. The specification required for each product needs to be carefully defined between customers, the marketing department and the production department and the cost implications need to be clearly understood by each group.

In some industries, particularly where the raw material is organic and variable from season to season, for example rubber latex, process control in which a laboratory checks the nature of the original raw material is required. The information is fed to the production people to assist them throughout the plant. This requires that process control staff work in the same department as the production supervisor in each part of the plant. Cooperation between these two groups is critical to production of quality in this case.

In most plants attention to a correct specification and allowable tolerances as early as possible in the plant can provide substantial cost savings. This particularly applies to purchasing the

correct raw materials and consequently avoiding the necessity for rework and the production of excess waste.

Recent accent on quality accreditation, involving the ISO9000 series of quality standards, has emphasised the need for a satisfactory management structure if a quality standard is to be met. The first step in obtaining some accreditation is to see that there is an organisation structure and that it is operating efficiently. This dictates that management has defined job descriptions, measurements of performance, proper production planning, quality control and cost control functions. This is true of course, for any of the many activities required to manage a company. This first step towards accreditation is very important and when combined with a philosophy from the top down within the company that quality is important will lead to a recognition that quality is made by people through their attention to producing components and products with pride in achieving a required standard. A caution in this respect is to see that the sales and allied executives, who pushed for the accreditation to make the sales job easier, having achieved accreditation, then pay insufficient attention to continuity of quality, process control and feed back requirements from customers. Achieving quality to a standard is a continuous, all embracing process.

White [32],points out that "continuous quality improvement is a global approach to business development that establishes an integrated program through which a company can achieve continuous incremental improvements in its chosen key performance measures by focusing on better leadership of people and the improved management of business processes".

In his introduction White emphasises the need for a new approach to business survival. He draws attention to three powerful ideas to assist the management of a company; mathematical modelling, redesign of business processes and automation and quality. However he suggests we put aside these three management tools and only take them out as required for a specific job. "We must get back to basics and manage people for performance and work towards a continuous quality improvement strategy in all the functions and processes of a business." He emphasises management and leadership of people as the core function. He states that companies need to change because of shorter product cycles and at the same time our

products and services are becoming common place in an increasingly competitive market place with higher customer and staff expectations.

White reveals his scepticism of most of the business planning and corporate strategy of some of the business schools in which he estimates that four times the content of the courses compared with more fundamental items, is concerned with such items as the theories of accounting, business modeling, numbers management and what he calls pseudo-scientific business activities. The fundamentals, in his opinion, are the skills and techniques of managing people. This situation of imbalance he regards as ridiculous. The author believes that the use of the first of White's powerful ideas, simulation can be used to assist people management, not as a one off procedure but as a continuous part of an overall integrated operation.

**Information processing** The computer hardware and software cost revolution of the last decade has led to the demand for rapid production of information throughout the firm without the need for the many hours of clerical time which used to be spent to codify the data within the firm. To be effective, the data needs to be transferred into information. This involves correlation of the data in many different forms. The finance people need the information in dollar terms for their control of debtors and creditors and attention to cost standards. The production people need information about the level of production and their wage and ancillary costs. The marketing department needs to know the cost standards on which they can base their pricing and they need, for example, the forward order position and the gross margin they are achieving on each product in excess of materials, sub-contracts and wages costs. Much of this marketing information is required to prevent complacency associated with the common belief that an increase in the total dollar value of sales is the only important measure of business performance.

The net result is the establishment of an integrated service for the processing of information. Often this is in the production department, but it may be a function in its own right. The important point here is that the hardware and software throughout the firm be as compatible as possible to facilitate the interchange of information and the ability of processing staff to

move from one section of the firm to another should this be necessary. An over-riding consideration is to see that this function produces the information required to manage in a compact and easily assimilated form, rather than a fancy presentation produced by a software programmer with only a limited knowledge of, or interest in, the firm's activities as a whole.

### 2.4.5 Supervision and Motivation

As discussed in detail in the section on motivation, Chapter 2.11 and in reference [10] the principal of transfer of information and the follow up on what happened as a result of that message is fundamental to management. The supervisor presents a need to a person who can take action on that need provided the message is clear and the individual receiving the message is sufficiently motivated to act on the message.

Considering these needs in turn:

**The message** Before presenting the message there has to be careful preparation by the presenter. The facts behind the need have to be defined. The message has to be presented in the correct order and in such a way that the receiving person's experience, affiliations and background are taken into account. This initial approach should be followed by a request for any difficulties to carrying out that need and an explanation given as to why action should proceed. Finally, there is the need in general for a specific request for action. However there are some cases , such as people with a high ego, who have to make the final decision themselves . In this case one presents the facts which point to a logical conclusion but leave the receiver to point out the answer.

**Motivation.** Recognition of the experience and character of the person receiving the message makes it possible to motivate that person to take action. The psychological make up of the receiver is such that the supervisor needs to present the message in terms of that person's motivation. Fear can be a motivator, but this is not a wise long-term application of the principle. Such items as status, understanding why, desire for a detailed explanation, appeal to imagination, appeal to monitory advantage and alignment with a cultural or religious group are all important motivations when applied to particular people.

Leadership requires that both the above items are respected by the supervisor. The supervisor needs to be objective, logical and has a proven record over a period that advice given is of advantage to the follower. Integrity is important, since if the leader is not honest and fair, all staff in a department soon assess this situation and are cautious in responding to that person.

It is necessary to cultivate a matter of fact approach in dealing with success and failure in a way that is not personal, discuss the problem and its solutions focussing on the problem, not the person who presented the idea. When a complaint occurs, concentrate on a solution, not who produced the problem. This approach requires dissemination of this philosophy throughout the company. It does not mean that one is not outspoken about a mistake and that a solution should not be presented for consideration at a meeting. In fact the minutes of meetings for later review should set down the description of the item dealt with, action to be taken and who is responsible for taking that action

**Working with people** Some of the items the author has found to help supervision in practice are presented below:

- The most important function of a supervisor is to develop the people around you, your staff, your peers, your superiors and your friends
- Make visits throughout the plant and be prepared to discuss personal needs of individuals, their illnesses, their family ups and downs for example and give advice with discretion and in private.
- Carry out mental work sampling to check what is happening in the plant.
- Be approachable, that is, have an open door policy
- Review the motivation and needs of all your staff and help them as far as possible
- If people, because of past training, culture or personality, do not want to take responsibility plan carefully to change this, but allow time and understanding for change to take place
- Do not let personal problems fester. Tackle them head on if necessary
- Encourage confrontation about facts, not people

- Encourage flexibility and training
- Balance discipline with encouragement and in private

**The supervisor and the department** Some suggestions to assist supervision are:

- Explain the potential for the future and the changes which are liable to take place
- Present capital expenditure suggestions for approval to continually update the plant and present them in a form and at a time which is best for the organisation
- Do not blame others for your own mistakes; acknowledge help from your staff and supervisors. Don't rely for your leadership solely on recognition of some unique skill you might have, but be a developer of people, process, management and your company[7]
- Keep an up-to-date list of items requiring attention so that obligations, ideas and plans for improvement are not forgotten or put aside because of daily pressures.
- See that information channels are set up to give you and your staff the information to manage their particular responsibility
- Spend time to liaise with the finance and marketing departments and suppliers
- Make decisions when needed, rather than go by a consensus based on a broad discussion. Don't expect people to fill a gap if they are not specifically allocated that task.
- Recognise the balance required between quality needs and expediting production
- Encourage deadline consciousness throughout the department

### 2.4.6 Updating, Review and use of Industrial engineering

Updating products and the scope of production and design and the purchase of facilities, infrastructure and continual review of supervision and motivation, are necessary continuous functions for management and a prime task for production management.

Products have life cycles affected by fashions, improvements in design and technology changes applicable to the processes involved. It is imperative that a product and component needs analysis followed by a statement of requirements takes place regularly for all products and components. Following this assessment of needs the production process may need review

quite apart from technological advances in productive equipment and the need to accommodate a new measure of capacity or sub-contracting as expansion or contraction takes place.

Then there is also the need for a review of organisation structure and information supplied to each area of activity. People may have to move to more relevant areas despite being highly productive in the past on a project or department no longer required. As the economy changes new problems in motivation and supervision take place, some of which require re-structuring of the whole firm, from vertical to horizontal activity and vice versa. One needs to ask are all staff performing efficiently in their areas of responsibility and consequently can weaknesses be covered by further training or movement to a task more in line with particular abilities.

In the production area there is a need for a continuous review of layout and handling methods. This can be assisted by intense industrial and manufacturing engineering investigation. Overseas trips and bench marking are required to keep in touch with the latest developments to assess real improvement potential, and check out management fads which can divert executive energies unnecessarily from the real aims of the company.

There is no such situation as a stationary production department.

## 2.5 THE FINANCE AND SECRETARIAL MANAGER

### 2.5.1 Financial Strategy and Long Term Planning

#### 2.5.1.1 Strategies and plans

Long term refers to 5 - 10 years ahead and sometimes longer. Strategy refers to the overall means to achieve the long term targets, and strategies have to be transferred into practical plans if implementation is to be achieved. Means refers for example to such strategies as "achieve adequate market share", " invest in automation" , "compete with service", "compete with price" or even "become global". Each of these examples has major implications as far as the finance department is concerned and requires that wise investment and financial planning, as well as adequate marketing, production and general management action take place if these strategies are to be achieved.

From the strategies outlined by the board and the general manager, each department has to develop plans to achieve those strategies. For the finance department typical of these plans are those associated with the extent of borrowing involving the gearing ratio, i.e. the ratio of long term borrowing to the total assets of the company. Many large public companies borrow up to 40-50% on this basis but this is regarded as too high by many observers, including the author, and is currently causing very serious reconstruction both locally and internationally. If it is too low then it can be argued that insufficient use is being made of outside money at a lower rate of interest than a shareholder expects from dividends, capital gains or support through shareholder loans. Often the reasoning is that outside money can be paid back as compared with share holder funds which are relatively static.

To measure the degree of safety involved in borrowing, a calculation is made of the number of times that earnings exceed the interest charges. In a boom economy the temptation is to over borrow, or borrow on a too short term basis and invest in fixed assets like machinery which should be regarded as a long term investment in this case. This leads to an inability to pay the interest on time and possibly to bankruptcy.

### 2.5.1.2 Risk

The fundamental issue is that the greatest return in long term for a given capital can be provided by a minimum shareholder investment and a maximum amount of borrowed money. However this involves the greatest risk of not surviving should the earnings not be great enough to cover first an agreed repayment schedule, second the interest involved and third some intermediate wages/return to the shareholder. A more subtle form of this type of failure is where a successful trader accepts an offer from a bank to finance the purchase of factory premises in lieu of renting and subsequently finds the additional repayment needs are far in excess of the cash flow available with the result that the bank forecloses on the business.

As explained in connection with research and development associated with prior innovation and invention there is a time to invest and reinvest. The initial need is to ascertain the fundamentals before investing heavily. This is probably the greatest benefit from R & D associated with both the plant and the market place. The assessment of the potential for a project results in wise purchase of machinery and process or further development of an idea.[23] At some stage following laboratory activity and pilot plant experiments on a batch basis a trial into the market place may take place. Valuable new information then follows as to the market demand likely to take place and changes in design needed. This can be the time to invest heavily ahead of the competition and obtain the benefit of a high margin to provide an early pay back of the R & D investment. Many good ideas have been squandered by not reinvesting when a new discovery has been made at this early marketing stage of a new product or process.

Backing a new development of one's customer by providing generous terms of trade to help them develop can be a good way to ensure long term sales benefits from that venture if the relationship is one of integrity between customer and supplier and will be respected during the life cycle of that product.

Cash reserves can earn some interest in the short term money market with relative safety. This is achieved by placement for only a few days, weeks or months on the basis of easy withdrawal when required and is used by many retail concerns with highly fluctuating cash

flows. Liquidity humps, caused for example by holiday pay advances, payment of term loans and economic down turns or a bad debt, can be smoothed out by using hire purchase or lease facilities. Many firms prefer to lease premises and vehicles and charge the cost to expenses rather than tie funds up in buildings because they will earn more by investing directly in the working capital of their businesses, not in property. In the case of hire purchase, part payment can be made initially with complete title passing to the purchaser at the end of the contract since both capital return and interest are included in the payment schedule. In the case of a machinery lease there is no payment initially and at the end of the lease, unlike a building lease, the balance of the lease must be found or a new lease arranged to cover the balance. In the case of a lease the goods are not owned by the factory leasing the machinery so that depreciation is not an expense item which reduces profit unless special agreements are arranged.

Another area of financial management associated with risk is insurance. We can rarely afford not to insure. There is usually a need to insure in some form the following:

Stock and machinery against fire damage
Vehicle insurance, third party and comprehensive
Loss of profits and the need for wage and administration costs following a fire
Theft
Plate glass damage
Public liability
Product performance
Work care and health considerations
Superannuation and long service provisions

As a corollary to these needs there can be a need for attention to such items as security services, mail opening, locking systems, smoke alarms, burglar alarms, automatic lighting systems, internal auditing procedures and care with signature rights on company accounts.

### 2.5.1.3 Source of funds

The finance manager needs to be able to access funds to preserve liquidity or allow development if cash flow is insufficient to allow efficient operation. Term loans from a bank based on providing a lien on the company's affairs can provide long term accommodation, but an overdraft is usually subject to withdrawal at the bank's discretion and should therefore be regarded as a short term loan. Practical loan funds can be available from an insurance group often tied to an obligation to insure with that company. Then there are the merchant banks, often at a slightly higher interest rate. For types of hire purchase and lease contracts there are the finance subsidiary of banks, basing their loans on the equity in a machine plus personal guarantees. The simple interest rates applicable escalate depending on the risk involved. Typical rates are as follows:

| | Low inflation (2%) | High inflation (9%) |
|---|---|---|
| Bank mortgages | 7 | 14 |
| Bank with guarantees | 11-13 | 18 |
| HP and lease | 15 | 20-22 |

Factoring is offered by some banks and merchant houses. This involves a lien on a company's debtors with a default lien on the majority of a company's assets and sometimes personal affairs. The factoring house's accounting charges are added to high interest charges to give a very high real cost to this method of finance and this, combined with the fact that there is a potential for a sudden cut off in cash supply because of slow payments to the factoring house, makes this procedure hard to recommend since the total cost is close to usury.

It is important for the finance manager to ascertain the policy of the board as far as the securities which can be offered to obtain funds from financiers, the public or shareholders and whether directors are willing to provide guarantees should they be requested. Guarantees should only be given in carefully planned areas of absolute trust and even then with limits on, or control of, the amount guaranteed.

### 2.5.1.4 Financial advice

An important part of this department's responsibility is to provide warning signs if stock levels rise above budget limits. New technology may be necessary to overcome this, group technology and better production planning which takes into account lead times before ordering may be warranted. While theoretically "Just in time" leaves ordering to the last minute, this is rarely feasible in a less disciplined economy dependent on overseas shipping , and this needs to be taken into account when ordering. The work in process and finished product stock can be a major part of stock holding and any speed up of throughput will improve this position.

Stock values need to be realistic and reflect the fact that the stocks have still to be sold. They should not include administration costs or profit, or the value of processes or overheads, that have not been incurred up to the stage of conversion of the stock item to a component.. Stocks should preferably be sighted before acceptance to check the items are not seconds or out of date.

In some businesses an important measure determining profitability is stock turnover. This is particularly important for wholesale and retail enterprises. Stock turn is the number of times stock is turned over in terms of sales volume of that stock in the same period. If a stock of $30,000 average value, is subject to sales of $60,000 per month then stock turn is 2 per month or 24 times per year. In this case, typical of a very high turnover stock, a return on working capital of 24% per annum will result from a mark up of only 1%. On the other hand if the turnover of stock is only once in three months, like many manufacturers, the mark up on each sales dollar would need to be 6% to achieve the same return on working capital. These measures of stock turnover need to be under continual review and should apply to each product group of a firm, if funds tied up in stocks as well as price mark ups are to be kept under control.

An important rule for the accounts department is to see that the promised repayment by the company of a loan to the company is defined with the lender as longer than the company's ability to pay back that loan. Similarly for lending to others, keep the repayment time shorter

than your need for return of the loan. Build in a reserve. Remember that investment in plant is a long term investment in this context and should not be purchased with short term loan money. Many firms fall for this, even using bank accommodation, barely sufficient for working capital, to make a machine or outside share investment.

On no account should the financial skills of this department condone such activities as using employee superannuation funds under the effective control of the directors for the purposes of investment in the company's shares, in particular to boost their value in the market. Another practice of a very grey nature is that of an executive or group of executives utilising inside skills, knowledge of source of funds and the firm's technology to contrive a take over of the company from inside, unless of course this is encouraged and with the prior knowledge of the shareholders.

### 2.5.2 Financial Control Ratios

There are some liquidity and control ratios which are valuable to most firms and need to be regularly under review. Others are important for a unique structure applicable to a particular industry or organisation. Some of the more important of these are set out below.

#### 2.5.2.1 Liquidity ratios

There is an almost universal need to keep one's liquidity ratio under review. This ratio is defined as the current assets divided by the current liabilities. Current assets include readily convertible stocks, cash in hand and healthy accounts receivable. Current liabilities include trade creditors as well as short term obligations such as a pressurised bank overdraft. This figure should be close to 2 for effective management and the meeting of supply obligations. There are also still more stringent ratios such as a quick ratio which is primarily based on accounts receivable and creditor obligations. The author has found a useful, although conservative measure, is accounts receivable minus the total of both creditors and net current bank obligation. The aim is to give an excess in cash of debtors over all short term creditors including the bank.

Other current ratios used include cash flow from operations compared to average current liabilities during a given period, and working capital turnover ratio, i.e. revenues divided by average working capital.

For long term liquidity, there is of course the importance of preparing forward cash budgets and acting on their indications. Of the ratios applicable to the longer term are such measures as the long term debt ratio, being total long term debt divided by total long term debt plus the shareholders equity. There is also the debt equity ratio of total liabilities divided by total equities, and total long term liabilities divided by the total assets commonly referred to as the gearing ratio. For heavily geared companies there is the number of times that interest is covered by earnings. Unfortunately some of these long term ratios are only taken into account after the event instead of being acted on in time to correct a trend.

### 2.5.2.2 Performance ratios

In support of profitability and improving profit there are ratios involving return on assets consisting of net income plus interest less tax divided by average total assets. Then there is the profit margin again with interest less tax relative to sales revenue. There are also the same figures but with interest deducted from the earnings in a similar manner to the normal profit calculations. Wise examination of profits relative to the interest and depreciation included can sometimes give a better insight into the real return on shareholder's funds.

Analysis of expense can take place using expense totals in comparison to revenues. Assets use may be checked using revenues relative to total assets and the extent of receivables may be measured by dividing net sales on account by the average accounts receivable received during a period. As already pointed out, inventory turnover is another important criterion for some companies. In the same way revenues relative to plant assets can be valuable.

Stock market appraisal can be assisted using the rate of return on shareholder's funds by dividing effective income by shareholder's equity during the same period. The price / earnings ratio is also a useful common measure i.e. the current stock market price divided by the dividend paid for that same share in recent times.

### 2.5.2.3 Value added measures

Value added is the sales for the year minus the total of all bought in costs and depreciation, Brammer [30]. People's wages are not classed as a cost in this approach, they are regarded as one of the returns through their investment in time in the business.

People productivity is then measured by using this added value by dividing it by the total number of employees or an alternative measure calculated by dividing by the total cost of employees.

Asset productivity is measured by dividing the value added figure by the average of total assets used during the year.

Brammer considers that often the cause of trouble is not bad managers but primarily the application of out of date management methods, that is, less informed management unable to compete in world terms in business management because they do not use these value added measures of productivity. One could of course argue that good managers are the one's who know about and use these measures in their businesses.

## 2.5.3 Accounts Records and Ledgers

### 2.5.3.1 Debtor and creditor policies

Most manufacturing businesses, as distinct from retailers and some commercial concerns, work on the basis of credit terms for their debtors, their accounts receivable, and their creditors, their accounts payable. Letting debtor accounts stretch out too far not only depletes one's working capital and interest charges but invariably leads to a greater quantity of bad debts. It is better to accept some payment off a debtor account early than always insist on a payment in full and only finish up with a minor payment in proportion to each dollar of debt at the time of bankruptcy of a client. Note that discounts for rapid payment can be a trap. 5% discount for prompt cash on all orders accumulated over a long period can amount to more than the profit many firms earn on their sales when in a highly competitive market.

By not paying creditors within agreed terms on a fairly prompt basis the supplier tends to charge more and it is harder to negotiate the right cost for further supplies. An average for all accounts for many firms is 4-6 weeks. The best scheme is one in which one's reserves allow a very prompt payment on request by a supplier should they make that request and make goodwill with that payment particularly when that supplier does not make that request regularly. One of the nightmares of financial and general managers is having to cope with a weak liquidity situation which results in continual, often irate, requests from suppliers for payment while management is trying to run and improve a business.

### 2.5.3.2 Ledgers

The keeping of ledgers of sales invoices, expenses in both operational and capital categories, payments received, payroll wages and employee's tax payments are usually kept using accounting software or in a series of analysis books. For each period, say a month, payments received are recorded against the amount owed by each customer, after taking any new invoices into account, to provide the balance due and allow a statement to be sent to each customer. This statement usually breaks up the outstanding amounts in terms of 30, 60, and 90 day outstanding accounts. The key legal document in this process is the original invoice which was aligned with delivery of the goods. In a similar manner supplier accounts show the amount owing to the supplier and the supplier's statement should coincide with one's ledger. In either case it is important to query differences between the company's and the supplier's accounts in a direct and non-adversarial fashion immediately differences occur if good long term relations are to be preserved. A typical pull down menu for a traditional accounts program is set out in figure 14.

The profit and loss for a period figure 15, i.e. the income minus operating expenses applicable to that income, (after stock has been adjusted to reflect usage and depreciation of equipment has been taken into account), is calculated to determine the profit from operations for that period. The balance sheet figure 16, applicable to a particular point in time is calculated using the data inserted into the accounts program to show assets minus liabilities and therefore give an assessment of the shareholders' equity in the company. This latter amount equals all shareholders' share payments including any premiums on shares, accumulated profits and any

capital gains less company taxes on profits and dividends paid. In the balance sheet "current" refers, in accordance with accounting practice, to receivables due within 1 year in the current assets, and creditors and other obligations to be met within 1 year, in the current liabilities. This can entail the break up of a loan obligation into two parts in the balance sheet, one part as a current item and the other as a long term liability item.

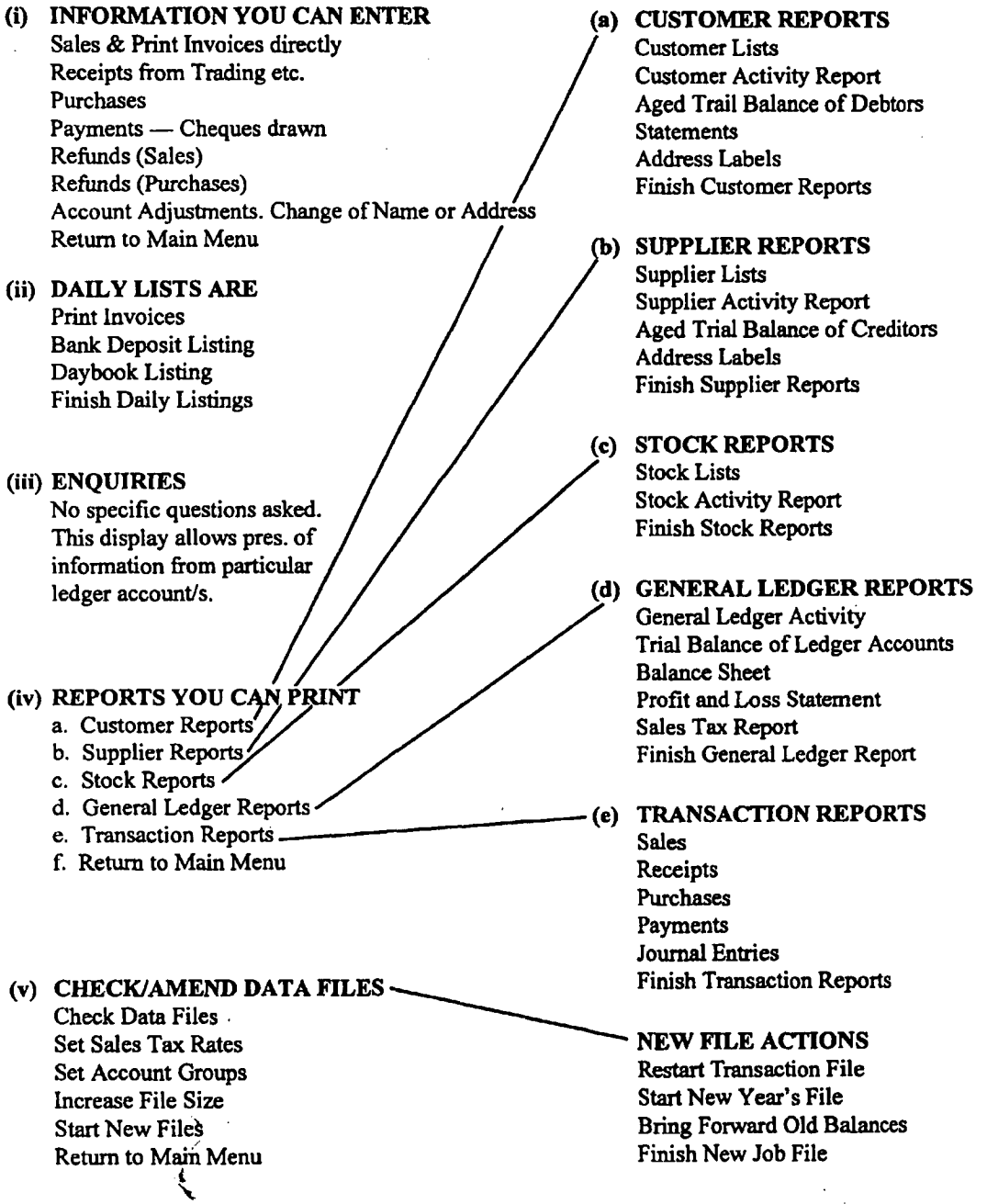



**Figure 14 A typical menu system for medium size business office accounts**

**PRINTING COMPANY PTY. LTD**
**ITEMISED PROFIT & LOSS STATEMENT**
**— YEAR ENDED 30TH JUNE, 1987**

| | | | |
|---|---|---|---|
| Sales of Books, periodicals and General Binding | | | 304,744 |
| **DIRECT COSTS** | | | |
| Paper & Ink | 39,118 | | |
| Type & Sub-contracts | 31,734 | | |
| Postage, Envelopes, etc. | 10,873 | | |
| Platemaking, Litho supplies, etc. | 12,033 | | |
| Freight, etc. | 2,296 | | |
| Subcontracts | 20,076 | | |
| Edit & Art | 5,809 | | |
| | | 122,619 | |
| Wages | 84,613 | 84,613 | |
| Payroll Tax | – | | |
| Opening Stock 1st July, 1986 | 63,200 | | |
| Closing Stock 30th June, 1987 | 66,450 | (3,250) | |
| Supervision and indirect wages | | 5,000 | 208,982 |
| **GROSS PROFIT** | | | 95,762 |
| **OCCUPANCY COSTS** | | | |
| Rent, Plant Hire, Lights Power & Insurance | 25,738 | | |
| Hire Purchase Interest Charges & other Interest | 6,409 | | |
| Repairs, Hand Tools, etc. | 8,524 | | |
| Depreciation | 11,210 | 51,881 | |
| **ADMINISTRATION COSTS** | | | |
| Accountancy, Clerical Fees & Typing | 2,269 | | |
| Depreciation — Motor Vehicles | 1,533 | | |
| Postage, Bank Charges | 786 | | |
| Travelling, Entertainment, Advertising, Sales Promotion | 7,537 | | |
| Superannuation | 3,427 | | |
| Sundry Office Expenses | 4,877 | | |
| Telephone | 4,274 | | |
| Salaries | 11,441 | 36,144 | |
| **TOTAL OCCUPANCY & ADMINISTRATION COSTS** | | | 88,025 |
| **TRADING PROFIT** | | | 7,737 |
| Loss on Sale of Assets | | | (537) |
| **OPERATING PROFIT BEFORE INCOME TAX** | | | **$7,200** |

**Figure 15 A typical profit and loss statement for use inside a firm**

| | Notes | Consolidated 1996 ($'000) | Consolidated 1995 ($'000) |
|---|---|---|---|
| **Current Assets** | | | |
| Cash | 9 | **1,327,477** | 861,711 |
| Receivables | 10 | **1,030,891** | 2,138,985 |
| Investments | 12 | **166,000** | |
| Inventories | 11 | **1,014,988** | 1,159,206 |
| Prepayments | | **62,412** | 85,540 |
| **Total Current Assets** | | **3,601,768** | 4,245,442 |
| **Non-Current Assets** | | | |
| Receivables | 10 | **87,303** | 70,776 |
| Investments | 12 | **183,682** | 195,267 |
| Property, plant and equipment | 13 | **1,238,334** | 1,443,943 |
| Intangibles | 14 | **576,759** | 668,282 |
| Other | 15 | **256,994** | 334,009 |
| **Total Non-Current Assets** | | **2,343,072** | 2,712,277 |
| **Total Assets** | | **5,944,840** | 6,957,719 |
| **Current Liabilities** | | | |
| Creditors and borrowings | 16 | **2,316,694** | 2,616,583 |
| Provisions | 19 | **497,578** | 601,010 |
| Other | 20 | **11,038** | 14,971 |
| **Total Current Liabilities** | | **2,825,310** | 3,232,564 |
| **Non-Current Liabilities** | | | |
| Creditors and borrowings | 16 | **1,052,124** | 1,303,066 |
| Provisions | 19 | **251,894** | 140,948 |
| Other | 20 | **22,950** | 24,300 |
| **Total Non-Current Liabilities** | | **1,326,968** | 1,468,314 |
| **Total Liabilities** | | **4,152,278** | 4,700,878 |
| **Net Assets** | | **1,792,562** | 2,256,841 |
| **Shareholders' Equity** | | | |
| Share Capital | 3 | **511,027** | 535,309 |
| Reserves | 4 | **1,501,355** | 1,661,626 |
| (Accumulated losses)/retained profits | | **(257,622)** | 11,842 |
| Shareholders' equity attributable to Pacific Dunlop Limited shareholders | | **1,754,760** | 2,208,777 |
| Outside equity interests in controlled entities | 8 | **37,802** | 48,064 |
| **Total Shareholders' Equity** | | **1,792,562** | 2,256,841 |

**Figure 16 A typical balance sheet for a firm**

The treatment of intangibles as part of the assets of the company requires a need to appreciate whether these items represent a real asset. Such questions to ask are whether the original formation expenses can be recoverable in the event of the sale of the company shell, whether the licenses, patents and trade marks are still contributing, and whether the extra premium paid on top of the original equity to buy into the company is reflected in the current profitability of the enterprise.

It is important to remember that it is not the computer that enters accounts data into the right column, it is a person . It is therefore necessary to ensure that the entries make sense by spot checking entries, in particular to check that capital and loan items are not confused with operating expenses, that depreciation applies to both assets and operating accounts and that prompt pay items of expense are not confused with creditor entries. Another potential source of error is miss interpretation of minus entries.

In any case it is wise to reconcile the bank balance at regular intervals with one's calculated overdraft using all payments received, cheques in transit from the past which have now reached the bank, payments made during the period and recent cheques still to reach the bank. This procedure prevents discrepancies accumulating to the point where a major investigation is required to find the error. It also has security implications. While accounts should be entered and checked to the last decimal point to reduce the probability of not picking up an error, the reporting of totals and sub-totals should generally be rounded and in a practical form to promote action by the executives receiving the information.

A depreciation schedule is to be kept for all plant. This record shows the original purchase price, the depreciation charged each year and the depreciation rate which applied. Any disposals or additions are set down each year so that the net depreciation figure is available for the profit and loss account and the net fixed asset figure may be applied to the balance sheet. Any capital gains or losses are also available through this procedure. Complete elimination of the value of an asset can usually only be justified by actual disposal unless straight line depreciation had been adopted. Typical current depreciation rates are 33% for electronic equipment, 23% for vehicles, 15% for office equipment, 7-10% for mechanical

plant and 5-7% for buildings. A long term development program, the Snowy River Scheme was considered as a 1-2% depreciation project.

### 2.5.4 Cash Budgets and Funds Movement Statement

#### 2.5.4.1 Cash budgets

The comments on long term borrowing and its affect on liquidity apply equally to the short term, one to two year liquidity needs. This is primarily controlled by doing cash budget predictions well ahead of real time. All expected input cash from all sources such as cash payments by debtors, repayment of loans to the company, new share and loan cash or sales of capital equipment are entered into the month or period when they are liable to be received, not when invoiced. Next all expected out goings are entered into the month or period when they are expected to leave the bank, i.e. within the planned terms of trade. Examples of these out goings are wages, payments to creditors, capital expenditure cash payments, loan returns, dividends and company tax, hire purchase capital and interest all in the month of payment. (Note that depreciation is not an expense in a cash budget). In the first three periods there is a need to insert the items from the previous year including accounts receivable and any special outstanding obligations. Note that there will be some items from the latter months of the profit and loss statement which will not apply and will lap over into a future cash budget. The calculation starts at the beginning of the first period with the opening cash book overdraft at the bank, ( the cash book overdraft is the bank position if all cheques written had arrived at the bank – not necessarily the bank balance.). Starting with the initial overdraft the input cash is added and the out goings deducted to give a new overdraft figure for the end of the period. This figure becomes the opening figure for the next period. This procedure is followed to develop the whole of the cash budget. The cash at bank position can then be plotted for the cash budget period. A sample of a cash budget is shown as figure 17 together with a financial ratios report extracted using a Budget Support system report, as described in chapter 4.

Usually the procedure just described provides a start for management coordination to prevent liquidity problems. It may be necessary for example to change when a capital expenditure item is to be purchased, revise terms of trade, or negotiate a lease instead of a direct cash

**Projected Monthly Cash Flow ($000s)**

| | 1995-96 | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opening Balance* | -1.165 | -1.165 | -9.997 | -8.534 | -7.880 | -6.028 | -5.341 | -6.178 | -11.997 | 16.230 | 21.871 | 22.599 | 27.865 |
| Cash Sales | 8.135 | 0.718 | 0.638 | 0.798 | 0.638 | 1.276 | 0.957 | 0.319 | 0.638 | 0.479 | 0.558 | 0.558 | 0.558 |
| Account Collections | 389.643 | 22.333 | 27.156 | 29.598 | 35.171 | 33.656 | 43.864 | 45.619 | 43.386 | 32.539 | 22.809 | 27.674 | 25.840 |
| Other Receipts | -12.533 | 0.449 | -0.500 | -0.500 | -0.500 | -0.500 | -0.454 | -5.032 | -3.500 | -0.500 | -0.500 | -0.500 | -0.496 |
| Total Receipts | 385.244 | 23.499 | 27.294 | 29.895 | 35.309 | 34.432 | 44.367 | 40.906 | 40.524 | 32.518 | 22.868 | 27.732 | 25.902 |
| Payroll Expenditure | 100.595 | 7.449 | 7.373 | 8.197 | 8.418 | 8.279 | 15.448 | 7.466 | 6.856 | 7.320 | 6.737 | 7.073 | 9.979 |
| Account Disbursements | 250.898 | 24.799 | 17.380 | 20.973 | 23.473 | 25.406 | 29.702 | 36.211 | 5.399 | 17.521 | 15.373 | 15.370 | 19.294 |
| Other Outlays | 10.111 | 0.084 | 1.078 | 0.072 | 1.566 | 0.060 | 0.054 | 3.048 | 0.042 | 2.036 | 0.030 | 0.024 | 2.018 |
| Total Outlays | 361.604 | 32.331 | 25.830 | 29.241 | 33.457 | 33.744 | 45.204 | 46.725 | 12.297 | 26.877 | 22.140 | 22.467 | 31.291 |
| Closing Balance* | 22.476 | -9.997 | -8.534 | -7.880 | -6.028 | -5.341 | -6.178 | -11.997 | 16.230 | 21.871 | 22.599 | 27.865 | 22.476 |

**Financial Ratios**

| --Profit-- | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | 1995-96 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Profit Before Tax | 10.327 | 7.036 | 7.743 | 4.918 | 10.641 | 1.624 | -3.516 | -0.125 | 0.548 | 1.210 | 1.346 | 0.098 | 41.849 |
| 10.0% of Total Cost | 2.557 | 2.486 | 3.213 | 2.699 | 5.316 | 4.623 | 1.947 | 3.203 | 2.337 | 2.670 | 2.657 | 2.782 | 36.489 |
| --Margin%-- | | | | | | | | | | | | | |
| Profit / Sales | 28.774 | 22.057 | 19.418 | 15.415 | 16.677 | 3.394 | -22.042 | -0.392 | 2.289 | 4.335 | 4.821 | 0.350 | 10.289 |
| --Ratios-- | | | | | | | | | | | | | |
| Cur Assets / Cur Liabs | 2.815 | 3.003 | 3.080 | 3.192 | 3.296 | 3.382 | 3.010 | 3.887 | 3.874 | 4.056 | 4.156 | 3.981 | 3.185 |
| Sales / Factory Costs | 1.527 | 1.398 | 1.326 | 1.279 | 1.248 | 1.082 | 0.914 | 1.063 | 1.119 | 1.130 | 1.136 | 1.091 | 1.194 |
| Debtors - Mth of Sales | 2.027 | 2.406 | 2.527 | 2.807 | 2.692 | 3.543 | 3.633 | 2.748 | 2.390 | 2.122 | 2.256 | 2.247 | 2.292 |
| Creditors - Mth of Sales | 1.562 | 1.589 | 1.636 | 1.676 | 1.663 | 1.753 | 2.069 | 1.317 | 1.306 | 1.228 | 1.213 | 1.313 | 1.632 |

**Figure 17 A monthly cash budget showing expected bank position over a coming year together with a financial ratios report.**

purchase. With a cash budget one is in a position to negotiate with the bank to obtain needed accommodation and still have time to go elsewhere if the bank is not receptive. Every effort should be made not to leave a request for finance to just before the time when the special need arises, or unreasonable demands may be made on the company. The bank is primarily interested in security for their loan and that the borrower can provide adequate cover for interest and capital repayments. This cover can be demonstrated using the cash budget.

### 2.5.4.2 Funds movement statement

A look back at how a company has received and spent its cash flow is a useful way of appraising the policy of a company. This information can be obtained by comparison of relevant items in two successive balance sheets, i.e. by subtracting the second balance sheet from the first one. A funds movement statement shows sources of cash and then distribution of that cash, see figure 18. For example investment in new equipment using substantial operating earnings shows that the board is confident about the future. Investment in a take over involving a need to invest in a long term holding in shares using overdraft facilities or

short term loans shows a highly speculative approach. Using earnings to reduce borrowings indicates a conservative approach whereas allowing accounts receivable to over extend to attract sales may be unwise, although tempting, in a highly competitive environment. Remember, as with the cash budget above, depreciation is a cash contributor in the funds movement statement.

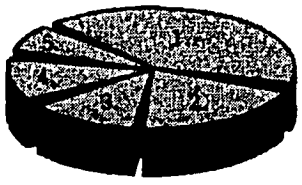
### 2.5.5 Costing

The financial controller needs to see that realistic product and department costs are available for management. While major emphasis should be placed on the overall profit and loss and cash flow considerations, both current and long term, and comparisons between actual results and budget as shown in figures 19 and 20, there is also the need to supply management with more detailed information to help them achieve the required, and mutually agreed, budget objectives. Current product and component costs need to be measured and under scrutiny and each department needs information on their contribution to keeping under control the expenses for which they are responsible.

This requires the accounting staff to be continually aware of the real distribution of wages and material costs as well as practical knowledge as to how to allocate realistic costs for the portions of the buildings used by each department of the plant as well as its administration. In addition, when assessing product and component costs, carefully calculated measures of the major overhead allocations are required, not just an average percentage figure. This latter need is essential in view of the variation within most companies of the degree of automation and administration applicable to each department. Proper allocation is required of depreciation and interest together with the infrastructure to support advanced technology as well as the clerical, marketing, management, administration, information and sub-contracting services applicable to the various activities of a modern company. Unless the cost accounting procedures are realistic, management by the departments, and in fact the whole company, can

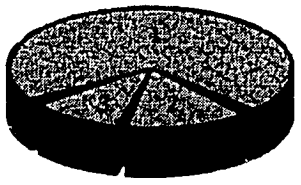
| For the year ended June 30, 1986 | | 1986 $'000 |
|---|---|---|
| **Sources of Funds** | | |
| Funds from Operations: | | |
| Inflows of Funds from Operations | | 1,990,292 |
| Less: Outflows of Funds from Operations | | 1,641,702 |
| | | 348,590 |
| Reduction in Assets: | | |
| Non Current | | |
| Disposal of Non Current Assets | 53,525 | |
| Advances and Loans | — | 53,525 |
| Increase in Liabilities: | | |
| Non Current Debt | — | |
| Current Debt | 34,420 | |
| Trade Creditors and Provisions | 56,236 | 90,656 |
| Share Issue | | 153,378 |
| Change in minority interests | | — |
| | | 646,149 |
| **Applications of Funds** | | |
| Increases in Assets: | | |
| Current | | |
| Inventories and Work in Progress | 96,510 | |
| Trade and Other Debtors | 71,183 | |
| Cash at Bank | 19,748 | |
| Other | 7,295 | 194,736 |
| Non Current | | |
| Fixed Assets | 223,225 | |
| Exploration and Development Costs | 9,818 | |
| Goodwill | 62,528 | |
| Advances and Loans | 9,336 | |
| Other | 6,650 | 311,557 |
| | | 506,293 |
| Less: Adjusted for Investment in Associated Companies that became subsidiaries during the year | | — |
| | | 506,293 |
| Reduction in Liabilities: | | |
| Current Debt | — | |
| Non Current Debt | 1,667 | 1,667 |
| Dividends Paid | | 53,731 |
| Income Tax Paid | | 83,417 |
| Change in minority interests | | 1,041 |
| | | 646,149 |

**Sources of Funds 1986**



1. Profit 44%
2. Share Issue 24%
3. Liabilities 14%
4. Depreciation 10%
5. Other 8%

**Applications of Funds 1986**



1. Assets 79%
2. Income Tax 12%
3. Dividends 9%

**Figure 18 A funds movement statement showing the source and application of funds over a financial year.**

| | FOR THE MONTH OF DEC 95 | | | | | Analysis of Performance FINANCIAL YEAR 1995-1996 | |
|---|---|---|---|---|---|---|---|
| | BUDGET | ACTUAL | VARIANCE +/- | ACTUAL AS % OF BUDGET | ACTUAL PREVIOUS YEAR | | |
| SALES | 48 | 47.3 | -0.7 | 98 | 37 | | |
| RAW MAT | 19.3 | 37.1 | -17.8 | 192 | 20 | | |
| WAGES | 14.4 | 10.3 | +4.1 | 71 | 10.4 | | |
| FY. OH | 3.5 | 3.8 | -.3 | 108 | 2.5 | | |
| ADMIN | 2 | 2.3 | -.3 | 115 | 2.5 | | |
| TOTAL EXP | 39.2 | 53.5 | -14.3 | 136 | 35.4 | | |
| PROFIT | 8.8 | -6.2 | -15.0 | -170 | 1.6 | | |
| DEBTORS (D) | 120 | 66 | +54 | 55 | 81 | | |
| TRADE CRED. (C) | 50 | 30 | +20 | 60 | 62 | | |
| BANKS (B)OD is positive | 5.5 | 4 | +1.5 | 72 | -2 | | |
| D-(C+B) | 64.5 | 32 | +32.5 | 43 | 21 | | |
| | YEAR TO DATE PERFORMANCE | | | | | | |
| | BUDGET | ACTUAL | VARIANCE +/- | ACTUAL AS % OF BUDGET | ACTUAL PREVIOUS YEAR | TOTAL YEAR'S BUDGET | % OF TOTAL BUDGET SO FAR |
| SALES | 252 | 237 | -15 | 94 | 197 | 407 | 58 |
| RAW MAT | 123 | 140 | -17 | 113 | 108 | 216 | 64 |
| WAGES | 50 | 45 | +5 | 90 | 51 | 90 | 50 |
| FT.OH | 19 | 18 | +1 | 94 | 19 | 35 | 48 |
| ADMIN | 12 | 13 | -1 | 108 | 13 | 24 | 54 |
| TOTAL EXP | 204 | 216 | -12 | 105 | 189 | 365 | 58 |
| PROFIT | 48 | 21 | -27 | 55 | 8 | 42 | 53 |

**Figure 19. An overall comparison report for general management and the board.**

be flawed and lead to incorrect decisions on retention and disposal of products, avenues for investment and appraisal of staff. Industrial engineers can assist the accounting function by determining practical allocations of wages, plant and buildings and clerical staff should this be necessary particularly where appraisal has to be by indirect assessment rather than book figures in the company's accounts. However before use of these figures, each portion of the product cost subtotals, with quantity taken into account, needs to be reconciled with the corresponding sub-totals of the total profit and loss figures of the company.

A common method is to present to the departments of the company reports of actual costs compared to expected budgeted costs. The difference is known as a variance, (a plus or minus not to be confused with the standard deviation, the root mean square of mathematical statistics also referred to as a variance).

GENERAL MANAGEMENT FINANCIAL REPORT

Month of ..... Financial Year .....

| | | *Actual* | *Budget* |
|---|---|---|---|
| *SALES* | | | |
| | This month's sales | $ _____ | $ _____ |
| | Av. monthly sales this financial year | $ _____ | $ _____ |
| | Est. value of work orders held | $ _____ | |
| *EXPENCES* | | | |
| | Direct purchases (adjusted for stock change) | $ _____ | $ _____ |
| | Purchases as a % of sales | _____% | _____% |
| | Wages | $ _____ | $ _____ |
| | Wages as a % of saïes | _____% | _____% |
| | Factory O.H.& Admin. | $ _____ | $ _____ |
| *PROFITS* | | | |
| | Gross margin i.e. Sales less (purchases+wages) | $ _____ | |
| | Profit this month | $ _____ | $ _____ |
| | Progressive profit this year | $ _____ | |
| *FINANCIAL* | | | |
| | Debtors month end | $ _____ | |
| | Trade Creditors month end | $ _____ | |
| | CBOD* end of month | $ _____ | $ _____ |
| | Debtors/(CBOD+creds) | _____ | |
| | Progressive capital expenditure this year | $ _____ | |
| | Progressive deprecn. this year | $ _____ | |

* Cash Book Over Draft - Total amount owed to the bank including cheques written or in transit but not yet presented at the bank.

**Figure 20. A routine general management and departmental report on current performance.**

### 2.5.6 Secretarial

Among the tasks which traditionally fall to this department are the company's administration responsibilities for such items as annual returns to the registrar and similar government authorities. Records need to be kept and time spent on meeting these needs. Data concerning shareholders, directors, secretary and office location as well as both current and annual, sales, wage and capital position all need to be kept up to date and capable of inspection at any time. Some firms are responsible for reports of their R & D expenditure each year. Many of these records and allied bank and accounts payable vouchers need to be kept for the previous 7 years for legal reasons.

Coordination of an agenda and the minutes of well thought out minutes of meetings is another function often included in this department's responsibility. The conduct, and documentation of these meetings is very important as far as the profitability and long term viability of a company is concerned whether the flow of information is from the top or from lower in the hierarchy of the organisation. Conclusions in the minutes need to be clear and backed as far as possible by a concerted effort to implement the joint decisions. In general there should be a description of the agenda item discussed then the action to be taken and finally the person responsible for action. Personal viewpoints should be encouraged but not accented in the minutes unless specially requested by the advocate of that view. Differences should be about the subject rather than related to an individual's approach.

Access to legal advice in connection with the company's accounts and contracts often leads to the accounts department being responsible for liaison with the company's solicitor and this source of advice needs to be available to others as well, including those on the board, the general manager and the marketing and production managers.

Financial information, both audited and current, needs to be directly accessible to board members as well as the general manager to ensure that board members can be fully aware of current financial facts rather than having to rely on financial reports well after the event.

### 2.5.7 Presentation of Data and Delegation

Accountants are sometimes very detail conscious and mostly demonstrate a skill in following through a project to its conclusion. However these admirable qualities can weaken their ability to delegate a task to others in their office and in the plant, and retard communication. Recognition of this quality by other areas of management, particularly the general manager, allows encouragement and promotion of delegation and communication and assists the use of the special project skills of this profession for the benefit of the company.

As indicated in earlier comments, technology has provided new tools and facilities for many professions and this applies particularly in the accounts area. No longer is there the need to spend time on calculating results to the extent which applied only a few decades ago and spend weeks preparing and revising budgets. Calculation is done by software. But there is an even greater need now for wise use of these new tools, correct entry of data and the spread of sound financial information within the staff of our companies to enable all concerned to survive in the current competitive climate. There is also now less resistance by accountants to revising and improving budgets since this is a relatively easy process following further joint executive input.

To earn an income many outside accounting firms are concerned primarily with tax reduction and returns for clients, but in a company the aim is to help the firm to obtain a satisfactory profit and stable financial status in short and long term. In a company the need is to make a profit rather than make tax reduction the major administrative task. For this reason it is inefficient to expect an outside accountant, or even the general manager alone, to prepare the budgets and forward plans of a company, without in the case of the accountant, the opportunity to fully understand its continuing operations. At the same time positive implementation of agreed budget plans can follow personal participation in the formulation of those plans and this dictates that the inside team has a strong say in the agreed budget plans for a firm.

Presentation of accounting information should be designed to obtain action when required. Financial information therefore needs to be presented in an acceptable form. If the receiver reacts favorably to bar charts use these. If experience shows that pie charts clearly portray the message, present conclusions in this form. If the board needs to consider decisions involving some hundreds of thousands of dollars do not include data to one or two decimal places. If the person receiving the figures desires them in columns use these, but try and aggregate groups of data to give a guide as to where action might be justified. Some people want the detail while others want the general. Remember that most people prefer to receive data in sufficient time before a meeting to appraise that data prior to the meeting rather than be asked to make an impromptu decision at that meeting.

## 2.6 THE SERVICES MANAGER

### 2.6.1 Organisation

While the formal structures described in sections 2.1 to 2.5 above define the principal areas responsible for direct action to achieve the objectives of an organisation there has developed, particularly over the last three decades within the industrial world, a need for specific back up by specialised support services to assist in decision making.

Recognition of this situation is particularly important when examining the needs of industrial management. There has been a tradition of trade training, and unfortunately also in the training of some professionals, that has left a belief in hierarchical and authoritarian discipline, to the point in some cases where advisory services are rejected or not respected. Training is therefore required in many cases on two fronts. First the manager needs to be aware that his/her success depends on real performance and that respect and recognition will follow an ability to use the skills and factual information of the service providers to enhance that person' career. Second the service provider needs to learn how to persuade supervisors into taking action and develop the rapport which allows improved performance to be implemented without tension and confrontation. Of particular importance for the service provider is the need to relate the presentation of one's message to the psychological make up and background, both personal and educational, of the person receiving the message. Next is the need by both parties to understand that feed back and follow up are not interference but necessary parts of action following a request. All messages should of course carry with them accuracy, integrity and sufficient authority to promote action without having to resort to a higher authority to force a change.

Examples from both the production and finance departments illustrate how important these relationships are in a modern business. A production manager being responsible for getting a product through the plant on time may find the quality or cost are out of line with the standards expected. He has a decision to make, to expedite delivery at a higher cost or change the process and deliver later than originally planned and upset a customer. At a minimum he

needs to plan to prevent a recurrence of the problem. He will need every help from the service people to assist him to get through this situation. Another case is that of a finance manager who sets out to make acquisitions to increase market share and so make it easier to obtain satisfactory prices for the firm's products. Unless he takes into account the technology and knowledge capital in his own and in the target company , the state of technology and the capacity of his own and competitive companies, both locally and overseas, his efforts may only lead to a dangerous waste of capital. He needs the back up of service advice from engineers and production people directly aware of the global technology situation prior to any investment. In a recent case a cashed up company, previously very successful in its industry due largely to its dynamic high pressure shop floor supervisors and wise technical management, reduced its technical leadership and then invested heavily in another industry it knew little about, as far as markets and specialist technology were concerned. The result was a failure because supervisors of this type are only effective in an industry where technical process control is part of the service structure and backed by top management. Without it the supervisors were impotent to improve the target firm as they had hoped. Obtaining market share was a costly failure. In the opinion of the author this large public company has repeated this same mistake several times, that of thinking a financial approach alone is all that is necessary in a take over, and except for one of their original products using advanced technology they would now be on their knees. They needed wise technology, market and production service advice to augment the limited knowledge of accountants and lawyers on the board who unfortunately were not equipped with any of the necessary technology and production management skills.

The place in the organisation for the service department is closest to, and reporting to, the head of the department most in need of that help. Should the department head be insufficiently aware of the importance of the advice provided, or simply not confident of being able to supervise the specialty involved, then the service may be allocated to a separate service department reporting to the general manager. Such departments as production planning, quality control, cost control and personnel will generally report to the production, financial or independent service department involved. With the need for information technology and control of computer software and hardware standards throughout the firm as

well as engineering and research and development activity, these items are often included in the separate service department rather than responsible to the key departments described in sections 2.3, 2.4, and 2.5 above.

### 2.6.2 Growth of the Specialist Functions

Some form of production planning, quality and cost control have been recognised as important aids to the prime departments since the industrial revolution. Following this, in the last three decades in particular, there has been first, a greater emphasis on industrial engineering as an aid to people and facilities planning, and then the extraordinary rise in the application of computer calculation and software packages which speed up both communication and the transfer of data into information to further assist management.

Information and computer technology has simplified some tasks and extended the potential of others. Integration, through improved communication, of each of the direct action departments including liaison with customers and suppliers is becoming essential for survival. Software packages and computers are simplifying some of the application of such professions as accounting, engineering, marketing and law and creating new specialist areas such as that of the information technologists. Even more recently there has been the wider use of probability linked to apparently random data and using biological analogies. Information combining new mathematics, probability theory, computers and data mining, is revealing new relationships in industry, medicine and society to contribute another specialist function to assist management.

Parallel with these additional tools to assist manufacture and industry in general have been the effect of political changes in the western world which have led to cultural changes affecting the relationships of staff, workers, supervisors, managers and shareholders as well as the overall communications systems of which they are a part. These changes have led in turn to the introduction of new freedoms to operate in what was in the past a relatively hierarchical method of operating in our firms and has given rise to an increased need for specialist services allied to personnel, staff selection, sub-contracting and decision making. For example one of

the effects of the rapid spread of relatively unrestricted globalisation of capital investment has been to leave some Australian firms, smug after years of security in a local economy with rich raw materials and agricultural abundance, vulnerable to take-over bids by overseas companies. If this continues it will leave our economy, and the living standards within whole industries, strongly dependent on overseas interests in the future. As the far sighted L.A.Zadeh , a prime mover in new developments in logic mathematics, pointed out to the author in mid 1999, this has opened the door to a new more subtle form of colonialism which will affect our management in future. The president of the Thailand Society of Automotive Engineers in a submission to a Pacific area automotive conference in Melbourne in May 1999, when asked to comment on the advantages and disadvantages of globalisation made a very cogent point in suggesting that the process needs to be fair, to prevent still greater disparity between rich and poor internationally.

Summing up, engineers need to be aware of the political pressures on their organisations, their skills and their profession. They need, in general, to widen their horizons and play a major part in managing the balance between technology and business skills through participation in top management and a recognition of the special contribution they can make by the harnessing of service skills to give us a competitive edge. If we do not adapt to this need, nations with an in built culture of "buy and sell", i.e. a "shop keeping" mentality will use us primarily as a supplier of cheap raw materials and a buyer at a discount of their excess capacity.

### 2.6.3 Cybernetics, Servo-mechanisms, the Service Function and Management

Examining the servo-mechanism process, the basis of cybernetics, is useful as it provides an analogy with the behaviour of a service ranging from a process control system to management action and as communication between individuals.[10]. For effective communications between people the organisation of a firm needs to operate in a similar manner to a servo-mechanism as shown in figure 21. If we do not organise communications in this way we will demonstrate the faults of a servo out of control, and will not get the benefits of the service functions.

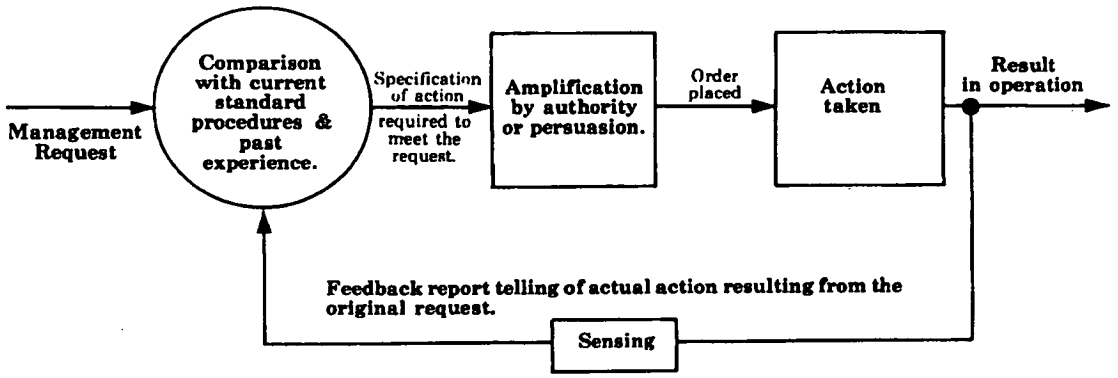



**Figure 21 Management request presented in the form of a feed back process**

An example of a simple servo is that of a furnace control using a thermometer pointer to contact either of two extremes, high and low, limiting stops. Figure 22 shows the circuit of a controller of this type together with a corresponding servo diagram analogous to that of the management servos which are shown in figure 23. Referring to figure 22 when the temperature rises to a certain level the pointer hits the top stop and causes a micro current to flow through the pointer to a relay. The relay leads to amplification so that a strong current cuts off three phase high power to the furnace allowing the furnace to cool down until the lower stop in the thermometer reactivates the full current and the furnace again receives power. It can be noted that there is a potential for hunting in which the temperature can move in waves oscillating about a mean. Should a short circuit take place which voids the feed back process the temperature will keep on rising or falling and the process will be out of control. It is essential that the standard and the allowed deviation from the mean be established and kept under review. Another need is that there is sufficient amplification to ensure action and that the micro current is sufficient to ensure the "authority" of full power required to provide the furnace power input. In industry a further analogy with the "inertia" of Newton's laws in dealing with organisations and their staff also applies to a servo's operation. If major changes are needed then the inertia of past methods needs to be overcome. The size of this hurdle depends on the number of people involved and the depth of the cultural changes needed. A large force, i.e. amplification, may be necessary to achieve the initial changes followed by a long period of consistent pressure over a period to introduce further changes.

By considering more complicated servos we can appreciate the need for comprehensive service and reporting within the management of most organisations to enable them to survive and develop.

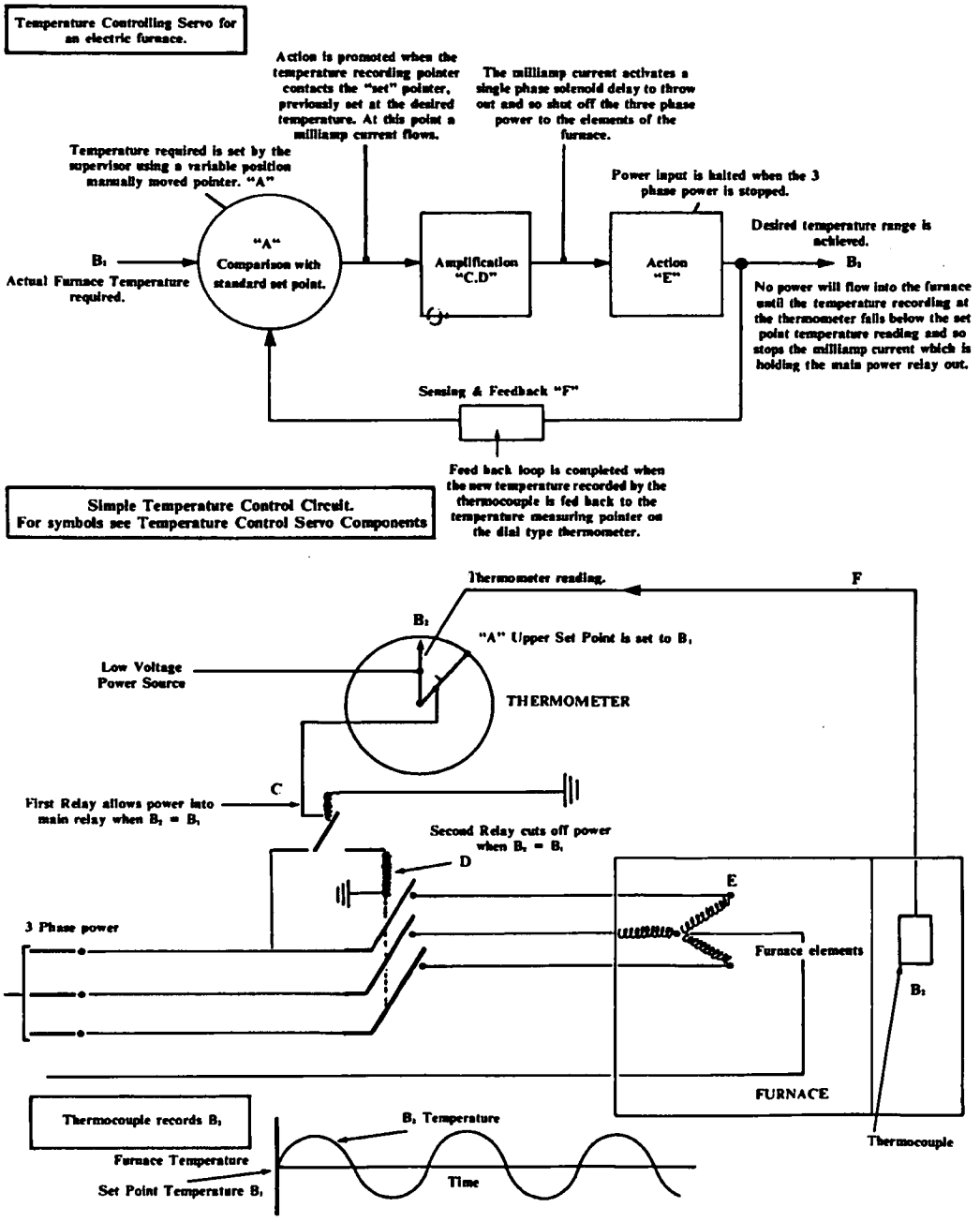



**Figure 22 A temperature control circuit for a furnace together with the analogous servo diagram for the same process**

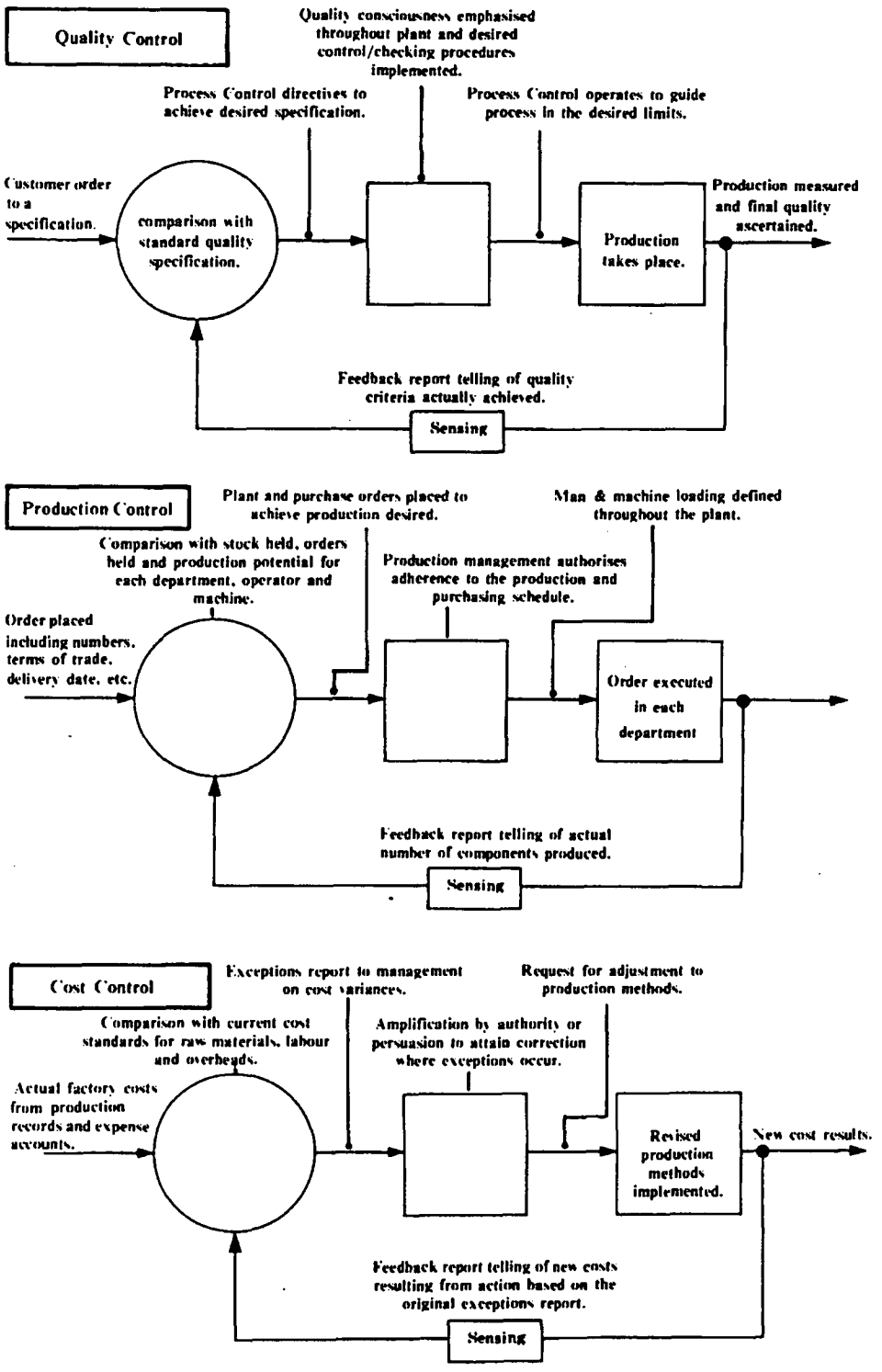



**Figure 23 Servos demonstrating the operation of the quality, production and cost control services**

A first example to demonstrate how complex control can become is that of a battleship which has to fire its guns at an enemy having regard to its own rotational and linear movements about and along three axes. At the same time there is a wind to be accounted for and variations of atmospheric conditions between the ships. All this assumes that the object being attacked stays in the same position so that adjustments are required to accommodate for the time factor due to the time when the shell leaves the battleship and the time it reaches the target. A whole series of servos are required to cope with this situation. On top of all this the observer is using field glasses and although the glasses can be moved quite rapidly, the gun which has to follow, weighs many tons and has to be accelerated and decelerated to bring it into position to fire, hopefully at the rate the field glasses move. It is not surprising that these ships have become vulnerable to attack by aircraft, guided missiles and submarines as the sensors and servos of the enemy have become more effective. There is clearly an analogy with the endevours of a manager to keep a company on an even keel as it travels through the rapids of competition to meet its targets.

Another example is that of biological control. In our bodies, the senses and our brains and glands combine to control much of our behaviour. The glands secrete materials which act as feed back links to our responses. Our brains process these responses. Not only do we respond to stimuli from our more obvious senses of sight, sound, taste and hunger, but we also respond to the way the messages relate to our past experience, learning and the psychological make up stored in our brains. This process is similar to that of a servo and our actions also follow comparison with the standards inherent in us. This logic is fundamental to an understanding of how to supervise staff in general and the operation of service people and their departments in particular.

If messages are passed to us which are unrelated to our experience and personality we sometimes react adversely to these messages and a sensible request may be rejected whereas the same request presented in relation to our psychological make up and past experience would be accepted and acted upon. In selecting staff, industrial psychologists take the view that an organisation needs a particular person to fill a niche. The aptitudes, skills and personality of an applicant has to match the needs of the organisation in all these respects. The

characteristics of the applicant needs to improve or compliment the existing people balance not just their technical skills. There are indications that groups can behave in many ways in a similar manner to individuals so that this needs to be kept in mind when tackling the reorganisation of whole departments particularly as far as the need to explain why changes are necessary.

A control system should be planned to operate within accepted limits relative to a standard rather than be subjected to a report based on every deviation from standard. Statistical thinking should control the action associated with an exception report. Over control can give rise to as many problems as under control. For example in controlling a machining process which has inherent variations in the tolerances of its products, control within an inherently variable process will only lead to frustrated over stressed people chasing unreal targets. Executive energy in this case would be better spent in trying to reduce the inherent variability of the process.

### 2.6.4 Engineering education and the services

Emphasising the versatility now required of the engineer Sharon Beder [33] sets out expertise required by the year 2010 in addition to those already supplied by a traditional engineering education as follows:

- Have enhanced communication skills
- Provide significant leadership beyond technology
- Become innovative and creative
- Be better life-long learners and more adaptable to new learning situations
- Be more accountable for the results of their decisions within the total context of economic, political, cultural and environmental issues
- Operate further within and across professions that are global
- Utilize quality improvement practices in all aspects of their use

The services described in the following sections are important for particular industries. In some cases they are obtained by consultation or by sub-contracting to meet a particular need.

What is important is that the engineer manager is able to comprehend the basis of each of these services and know what they can contribute, so that he/she can communicate with these specialists effectively and economically to achieve their contribution to the organisation's objectives.

To emphasise the extent of these changes we should be aware that many firms have only 25% of their costs in direct labour. Substantial sub-contracting / outsourcing is taking place with both local and overseas suppliers. Financial sources are changing as banks change their policies and their service moves from personal contact to electronic transfer and global funds movement. The combination of electronic circuitry and chips with numerical control has made robotics and automation possible which in turn has dictated that a sufficient volume of sales through international market blocks is now imperative for some industries to survive. A Canadian nickel mining company currently produces ten times the earlier underground miner's output using ground surface control of underground mining robots. Using this system mining can take place 23 hours of each day in safety. The electronic and audio visual communications engineers combined with mechanical designers and surveyors are now the key specialist services supporting this process.

One of the most dramatic affects of the computer revolution is the production of information in real time so that action can take place immediately rather than at a time well after the events have taken place. This has had a profound affect on the decision making process, for a group of people can now check the affect of their proposals at a budget meeting, as discussed in chapter 4, and at that same meeting or very shortly afterwards carry out cohesive forward planning as a joint venture. Results embrace not only better planning through direct confrontation and resolution of inputs by a range of those with the knowledge to contribute but also through the follow on determination to make the plan work which results from full participation in the planning process. This procedure contrasts with the previous method of asking an accountant, sometimes remote from the coal face, to prepare a company's budget for implementation by company executives who have had only a minor part in its preparation.

# PART B SERVICE DEPARTMENTS

## 2.7 PLANNING AND BUDGETING

### 2.7.1 Production Planning

Some form of production planning is required for every commercial and industrial activity to translate a customer order or executive proposal into a final product. There is no need for this process to be more elaborate than necessary. In a small business a job book may be used to book the work in for execution at a particular time which is shown in the book to be vacant as far as work load is concerned. Predictions of delivery time are made based on past experience of the time to complete the job after allowing for the time to obtain parts and the delay before preceding work is complete. To trace the work in the factory there is usually a card and a job bag created corresponding to the work. The card is placed on a visual updatable notice board at the point of control, usually in date of receipt order, while the job bag moves with the progress of the job around the plant until it arrives back in the office ready for use in invoicing after the product is dispatched. Where several departments are involved in the processing of the order, the card is moved from department to department on the notice board parallel with the movement of the job bag in the plant.

As the number of components needed to complete each product increases and the number of processes requiring the activities of a combination of machines, people and sub-contracts increases there arises the need for more elaborate versions of the simple planning system described in the previous paragraph. Reference to some of the reasons for this, serve to explain why a simple computerised version of the basic needs already outlined is insufficient in the larger plants.

A major reason for more elaborate procedures is the commercial pressure to reduce the time taken to deliver the goods.

This forces the introduction of three procedures aimed at expediting delivery:

- First is the apparently simple system of carrying stocks of both sub-contracted components and finished products. This introduces the extra cost of financing these stocks. This financial cost can be minimised by specifying that orders are to be delivered just before they are required and by such techniques in the plant as group technology which can reduce the optimum batch size required for some factory orders.
- Second is the need to place orders such that many processes may take place in parallel and prevent a hold up at assembly. This leads to a need for the incorporation of critical path analyses into the production planning process.
- Third is the fact that financial considerations dictate that availability of machines, skilled labour and space are limited and that accumulation of particular demands can overload facilities on occasions.

Another reason , too often neglected in considering why production planning systems do not all run as smoothly as desired, is lack of input and communication between the company's overall policy making group and the production planning department. This is one of the reasons for the accent on participation in the process of budgeting presented in chapter 4 of this thesis. In a review thesis [25] following a thorough examination of MRPII (Manufacturing Resource Planning, a transaction processing system) and potential for integration with the JIT(Just in Time) approach, the writers point to two major inputs required as input to any master scheduling system. First is a "capacity policy" as specified in the top management planning process and the still more comprehensive "overall policy input" based on the objectives and strategies of the company and its marketing, production and financial plans for the future. Oliver Wight [34] in his book on MRP (Material Requirements Planning), states that " The operating and the financial systems are one and the same. They use the same transactions, they use the same numbers. The financial figures are merely extensions of the operating numbers". The conclusion is that the overall policy of a company, incorporated in budgets established after having considered information from the production department, is a vital input to any factory planning system. Another aspect of the need for further widening of these planning systems was raised in a comment by C.MacKinnon [35].

He raises the question of the impact of e-commerce on ERP emphasising that the investor and customer views need to receive more emphasis. Again the question of overall budget policy which takes these questions into account needs to be the starting point. The work of G. Homer [11] and S.Bradshaw [13] also demonstrate this need in the cases of MRPII, ERP(Enterprise Resource Planning ) and AP&S ( Advanced Planning and Scheduling, a decision support system) for overall policy to be fed into the planning system. There is also some evidence that where the personal communication system is strong in a firm, and an open door management policy exists, that the effectiveness of these systems is improved.

Despite the comments of the last paragraph elaborate systems such as MRPII, ERP and AP&S are in use in their original and modified forms to perform an important function in their companies, our emphasis is to how to make them more efficient and less costly to run.

Before leaving this aspect of planning another important part of the process should be mentioned, the task of following up on instructions, the expediting function, concerning labour and machine allocations, waste and rework, and the actual times taken relative to expected times.

### 2.7.2 Project Planning

The critical path method, CPM, program evaluation review technique, PERT, or versions of these, [40] have been used for planning and estimating times and costs, and subsequently to assist in keeping a project in line with promised times and budgets. The reasoning behind it is valuable for all planning work but particularly useful for large construction projects, for starting up a company or for moving a company to new facilities.

Figure 24 shows a typical chart setting out the stages in production to develop a product. The critical path which defines the succession of stages most likely to determine the time of completion of the product are joined by a double line. The 13 stages required to complete the work are identified by the larger circles. The numbers at the middle of each line joining a large circle are the expected times, with an identifying letter, to complete the advance to the next stage. This expected time is calculated on a probability basis to be a sixth of the total of

the optimistic time plus 4 times the most likely time plus the pessimistic time. The small circle includes the earliest expected date on which the event will occur and the square the latest allowable date for an event. The other numbers next to the large circles are the expected times by the alternative faster routes which are not the limiting cases.

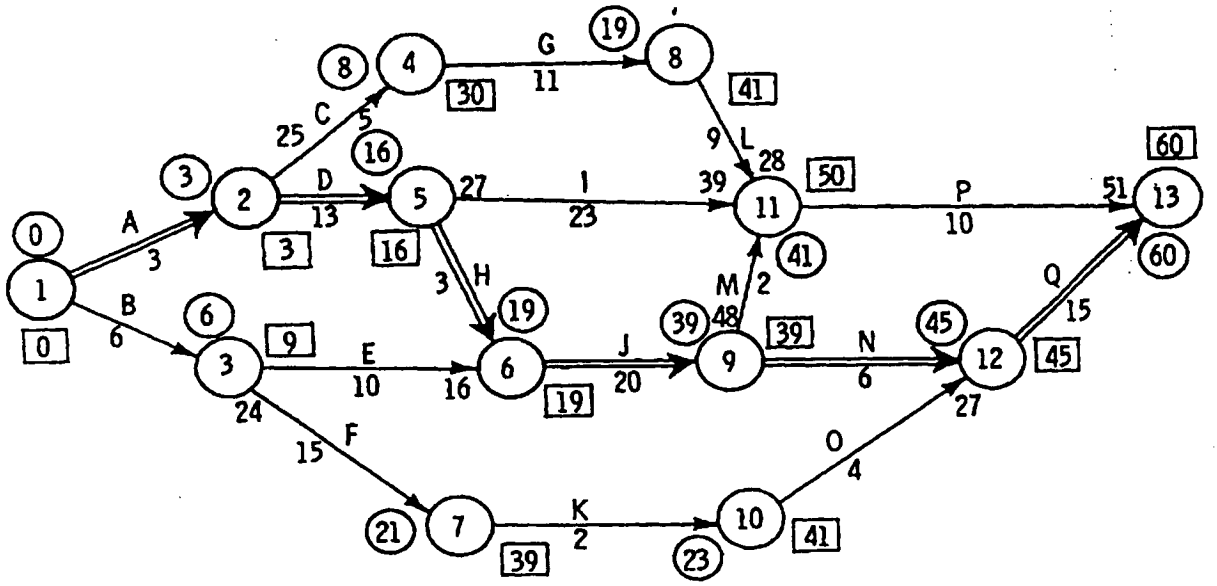



**Figure 24 Chart showing a critical path and the time estimates applicable to each stage of a project**

Not all activities making up a project are of equal importance; delays in a few can adversely affect the whole project. The critical activities control the duration of the project so that attention is focussed on them to keep the project on schedule. The path joining the processes that are critical is referred to as the critical path. This analysis tells when to be concerned and take action about progress. Excess labour, in a situation that is referred to as the "total float", can be moved from operations with plenty of time free to those on the critical path. Sub-contracting may remove the bottle neck. Investment in new machinery may be necessary or there may be a need to run further operations in parallel or even delete a process.

Cost estimation can be expedited, particularly when a proposed plan involves substantial construction costs, through the services of a quantity surveyor. This assistance enables

practical prior estimates to be obtained before proceeding to tender and can assist later with the tender documents.

The works manager in charge of a project should be armed with a critical path plan and a mechanism for its continual review as well as a reporting procedure to assist with his/her management.

### 2.7.3 Budget Planning Meetings

The accent in this thesis is on the importance of forward planning and the achievement of that plan. This need is clear from this review of each department's function and the importance of liaison between staff, between departments and with customers, suppliers and financiers. Parochialism in a general sense can negate long term efficiency and survival. Chapter 4 is concerned with the development of software and procedures for facilitating budgeting and improvement in coordination particularly at the senior levels of management. The following is a brief statement covering the main contributors to the budgeting process under the leadership of the general manager/ managing director.

Budgeting usually starts with a **marketing manager**'s forecast based on the facilities available, with a potential for new sales if new processes and investment are economically possible. Sales optimism may need to be guided to items of best gross margin rather than only chase a target of increase in the numerical or dollar value of sales. This department should reflect market trends in products, prices, fashions and quality requirements, as well as life cycle expectancies and feed customer needs and viewpoints into the budget meeting. Practical terms of trade which draw a compromise between the benefit of immediate cash and terms customers expect should be tabled together with the types of sales contract proposed. The extent of advertising and public relations expenditure recommended, the method of distribution to customers and the sales wages, vehicle and liaison costs of the sales department are also required to allow a practical budget to be negotiated.

The **production manager** contributes estimates of wages to meet the expected sales including the variations expected for each period ahead including holiday pay and any redundancy payments. Expected supply costs and expected stock targets are needed. The cost of any further facilities is required to meet increases in capacity or new processes. The production manager comes armed to the budget meeting with data to clarify these questions together with estimates of repairs and whether capital should be found to update some equipment to reduce costs. The requirements of power, gas and heating in the coming period and the freight, insurance and security needs also need to be specified. Of major importance is the question of how much sub-contracting is advisable and at what cost and terms of trade, or even whether it would be best to invest in a sub-contractor's plant if this is possible. Labour turnover and training costs and the level of wages may have to be changed to remain competitive. Redesign of the product, in conjunction with sales and customers, could be needed to reduce the number of production processes. Finally it may be necessary to check whether sufficient updating investment is taking place by comparing current plant capital proposals with the current book depreciation rate. The desired timing of capital requirements also needs to be presented to the budget meeting to check whether cash is available at that time or whether some form of spread payment such as leasing or hire purchase investment or disposal of an existing plant item would be more appropriate to preserve working capital. Any queries on the current presentation of control accounts should now be aired to check that the accounts divisions and items reported are the most appropriate to help management of production in the future. For example, one should query whether the departments and components costs now the subject of financial control reports are still appropriate?

The **finance manager** has to provide details of the factory overheads and administrative costs including office clerical costs together with expected pay back of loans and tax obligations as well as any sundry non-operating income. Policy on desirable reserves and availability of finance also need to be set down.

The factory overheads include such items as power, insurance, repairs, plant depreciation (usually spread, for the purposes of the budget, evenly on an estimated basis over the budget period), and interest where that interest is primarily concerned with machinery based capital.

The administration costs consist of clerical, administrative and general management wages, office costs, phones, fax and e-mail costs, bad debts, vehicle depreciation and external training and legal and accounting fees.

The **general manager**, as chairperson of this meeting, having checked that all necessary data is available and board policies explained now asks that the budget coordinator combines the data from sales and production with the overhead and administrative data. It is best if this data is coordinated by an inside staff member such as the finance manager, or an engineer skilled in budgeting, who presents back the overall profit and loss statement for the period of the budget and probable cash position at the bank for the whole span of the budget. These budget predictions are then presented back to the meeting as quickly as possible, using such a system as that explained in chapter 4, to preserve interest so that any weaknesses can be thrashed out, revisions made and a policy developed to tackle any deficiency in capital needs outside current bank accommodation well before any cash flow question becomes critical. It is important from a human relations point of view that each executive sees why any compromises to their original requests needed to be made to produce the best overall budget for the company. Each executive should come away with their part in implementation clear in their mind, as the aim of the budget planning is to provide a practical guide to future action.

The general manager, in fact all management executives involved in the budget planning including the **board members** should now, before final approval of the budget consider any restructuring needed during the budget period or longer, as a result of their deliberations. Examples are products to be phased out, activities to be extended to new industries, overseas investigation of technology advances, areas for R&D investment, staff development, and major financial implications. The board, although their policy input has already been taken into account, would at this stage normally be asked to comment on the proposed plans, ratify the thrust of the budget and direct that it be implemented.

In chapter 4 a comprehensive approach to overall production planning and software to expedite this process is presented. This process of coordinating overall policy and at the same time providing key policy input data for the production planning, costing and pricing systems

referred to as a Budget Support System is a necessary prerequisite to some of the more detailed planning. In the opinion of the author attempts to combine the overall planning with the detailed planning systems, primarily by production planning system providers, has proved unwieldy and it is wiser to carry out the comprehensive budget support planning as a regular easily revisable process to produce the standards for other planning work.

## 2.8 COST CONTROL, MANAGEMENT INFORMATION SYSTEMS (MIS) AND INFORMATION TECHNOLOGY (IT)

### 2.8.1 COST ESTIMATION AND CONTROL

#### 2.8.1.1 Standards for cost estimation, cost control and pricing

**Standards from time and methods studies and material usage measurement**

Estimation of labour times and materials usage to obtain cost standards requires careful measurement of these criteria in both a production and an overall planning situation. Estimation of costs involves examination of both past and current operations for the direct production work as well as the cost of each of the main overhead and administrative categories. In addition to direct derivation of standards from the budget using the methods of chapter 4, these detailed production standards can be determined for new work or simply for particular local decision making by direct measurement using time study, methods study or work sampling at any time.

The major standards so important for checking the basis of pricing and production planning decisions may be developed by using local time studies. However these standards can be available more accurately as part of the budget preparation process by incorporating cost calculation into the software and data matrices which allow the calculations described in detail in chapter 4 and the notes below. The resulting standard data from the budget software can be used in ancillary software to directly produce prices for quotations and input to production planning software. The benefit of this is that the local time standards are not biased by personal views and measuring errors or subject to the danger of becoming out of line with the latest budget proposals. Again this overall approach is a method of aligning general management and board policy with detailed marketing, production and financial management, which is a gap in many Australian businesses.

As a plant grows it is important to continually predict the cost changes due to new methods and processes and update the standards accordingly. Typical cost centres for specific control are as follows:

* Direct labour
* Supervision of direct labour
* Component material and sub-contracts
* Processing of scrap and rework
* Specific factory overhead sub-totals, of such items as insurance, repairs, power, heating and depreciation
* Administration overhead sub-totals of such items as legal and accounting, advertising, clerical and sales wages, phones faxes and e-mail, bad debts and vehicles.
* Packaging
* Distribution

Some reminders in connection with accounts systems and overhead allocations are justified. The books of a company need to be aligned with the budgeting and cost controls, and this task should not be relegated by the accounts department to the too hard basket. Correct allocation of overheads is particularly important to avoid wrongly loading one product or process at the expense of another. This can occur if automation costs and depreciation are distributed equally over all processes instead of being allocated to where they belong.

As already indicated some firms include additional overall cost control criteria, based on value added reasoning, to focus on people productivity and capital productivity. "Value Added" is taken to be the sales for the year minus all bought in costs including depreciation as a bought in cost.[30] Peoples wages are not classed as a cost. The people productivity is measured by dividing "value added" by total cost of employees. Capital productivity is measured by dividing "value added" by the total assets employed.

Depreciation costs need to be broken down into each cost centre depending on the actual capital employed at that cost centre. Similarly other overheads and administrative costs need

to be distributed appropriately. The allocation of office wages to each product often depends on the number of invoices processed for that product's sales not necessarily the dollar value of the sales. This type of analysis of overheads is particularly important in the case of high capital, highly automated processes and wholesaling, often requires manufacturing engineering skills and measurement to complement accounting skills to prevent costs being allocated solely on the basis of product numbers or dollar value. Also failing to distinguish between direct and service wages within an automated department can lead to poor capital expenditure decisions and incorrect pricing of products.

It is important that standards and particularly estimates of direct labour hours be correct. An estimator may have a background of skill, in fact that could be the reason he was chosen as an estimator, but his estimates need to take average real times into account not the times he would take. Examination of entries and reconciliation of all time sheets with total hours paid is therefore important when making an assessment of times taken. This applies particularly when hourly rate costing methods are used.

Careful discipline in all these items makes for control over the total of all expenses and if sales are also on target a profit results.

A brief description of methods used above for time measurement as distinct from the budget method calculations are:

**Time study and methods study.** Stop watch measurement takes place combined with a rating of the operator's performance in terms of skill and effort at the time the study is carried out. The method used and associated machine operating speeds are set down as a reference for the future. This is particularly important in cases where this time is used for piece rate payment. Tact and integrity are required for this method to be readily accepted for payment purposes in long term. One of the difficulties with payment on this basis is the need to continually change wage payment rates as methods, and hence times, change. Typical of the span of performance ratings applicable to the stop watch times are 1 for a basic wage operator, 1.15 for an average operator and 1.33 for a top performer, all on the same task.

Since in the final analysis methods are the principal source of substantial improvement, way ahead of effort, methods study such as MTM, Work factor and Modapts are a very effective way of defining a high labour content process in sufficient detail to determine an average time, provide a detailed job description and promote further improvement. These methods study times are based on a statistical approach to assessing times originally from high speed camera studies. By adding each small component, typically in units of the order of 1/10,000 of an hour, a total element time and then total operating time is obtained. A reference for this work is the handbook for industrial engineering [36].

**Work sampling** A typical work sampling work sheet is shown in fig. 25 [37].[44] Repeated patrols on a randomly time selected basis sample production, and measure the proportion of man time and machine time spent on all activities to find, when sufficient statistically significant results have been obtained, a percentage of the total production time spent on all activities. When these percentages are applied to the total man hours of a department's cost centre for a given time and then that total is divided by the actual units of components produced over that same period from the production records, the net result is a time in man hours per unit of component. From the same study the machine efficiency of the room studied can be found together with reasons for delays and loss of productivity. Apart from the benefit of time estimation without using a stop watch, this is a very useful supervisory tool and way of detecting weaknesses in production.

The sampling procedure just described, whether carried out formally or informally, is an important tool for observing performance, weaknesses and strengths in a plant or office by a manager, as visits throughout a firm take place. Astuteness using this method as a solely mental process can be of substantial assistance to one's management as part of regular plant tours to keep in touch and aware of people needs, as well as factory and office activities.

| Operator Code | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| Machine No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Machine Operating**<br>**Operator working**<br>Attending machine<br>Checking work<br>Preparing for task<br>Maintenance<br>With supervisor<br>Other | | | | | | | |
| **Operator unoccupied**<br>Idle<br>Absent<br>Other | | | | | | | |
| **Machine Stopped**<br>**Operator working**<br>With supervisor<br>Checking work<br>Maintenance<br>Preparing for task<br>Obtaining work<br>Other | | | | | | | |
| **Operator unoccupied**<br>Waiting - Inspection<br>Waiting - Work<br>Waiting - Maintenance<br>Idle<br>Absent | | | | | | | |
| **Other Information**<br>Engineer at M/C<br>Supervisor at M/C<br>Other | | | | | | | |

**Figure 25 A work sampling data sheet used to collect machine and personnel activity data, assess potential for improvement and check production times.**

**Standards obtained directly from the budget** It is recommended that practical standards should be obtained from the budgeting process as the initial targets for production and sales. Using the methods described in chapter 4 in which all inputs and outputs, in cash terms to the company, are correlated to provide a forward plan the results are the cost of labour, materials,

factory interest and other overheads including depreciation as well as administration for each sub-assembly. The software in the program takes the labour cost per sub-assembly and divides it by the direct cost of labour per hour to give the standard time in hours to make each sub-assembly. This provides a practical total which can be used to check the sum of detailed hours applicable to the production stages to make that sub assembly. In addition the total cost of that sub-assembly is available as a standard for pricing. The materials cost per sub-assembly , which includes all out-source items, when added for all the sub-assemblies which make up an order gives the external purchases required to complete a contract.

Ancillary economic pricing, work load and machine load programs can be used with these standards and the resulting output information can be used as policy input into the comprehensive production planning systems applicable to some of the larger enterprises.

### 2.8.1.2 Cost control

Control is exercised by action based on the variation of a cost from standard. Action requires that a direct change takes place as a result of sufficient persuasion or motivation to cause a correction to be carried out. Follow up then takes place to check the result of the changes made and if necessary make further design improvements to process, product or skills to prevent a recurrence of the trouble. The best place to control costs is with the help of those involved in the department where the cost variances occur. To this end it is best for work teams to prepare their own charts of daily performance and analysis of reasons for down time from whatever source.

It is important to cultivate a straight forward, matter of fact, not confrontational approach, to out of balance costs. Concentrate on the need for action and finding a solution rather than a "whose fault" approach. (A wise principle for the whole plant). Respect by all staff of cost savings throughout an enterprise is essential to keep expenditure to a minimum. However watch that the fact that a capital improvement which involves a high cost does not inhibit a purchase recommendation because of the cost, when it will give a satisfactory return on investment and a lower operating cost in future.

Harmonious relations and team work in the plant with effective directives by sound management gives the lowest cost operation. In our economy the short term benefits of heavy handed hierarchical management are generally outweighed in the long term by adopting a policy of participation, delegation and people development.

### 2.8.1.3 Costs applied to pricing

While prices are not necessarily directly related to costs, the marketing department needs the basic cost as a starting point for their quotation calculations. The three main methods of obtaining a basic cost for this purpose before an amount for profit and contingencies is added to the costs, or modified to give an export price are as follows:

- standard costs for all components (sub-contract, material costs and overheads included in the standards).
- Standard costs for most components (sub-contract, material costs and overheads included in the standards), plus any other direct hours X an hourly rate* which include overheads and then add any other sub-contract and material costs.
- A total of all expected hours at each cost centre X an hourly rate applicable to that centre, plus sub-contracts and material costs.

* Hourly rates are calculated by first adding direct labour costs to all overheads, both factory and administration, and dividing this by the direct labour costs. This multiplying factor, say 2.5, is then applied to the typical direct wage in a department, say $15 per hour, to give an hourly rate of $37.5 per hour. This would be the case for a reasonably equipped workshop but not one that is highly automated.

## 2.8.2 MANAGEMENT INFORMATION SYSTEMS (MIS)

### 2.8.2.1 Description of a management information system

The structure of a clerical and reporting system to provide management information to the executives responsible for performance varies with the size of the enterprise. The aim is to promote action where necessary, not to create a more complex procedure than necessary.

However the advance of data processing facilities and communication equipment over recent years to provide real time information directly on the desk of those needing it, has enabled vital information to be available economically at key work stations even in a small business. One of the design criteria for an information system is not to over burden busy people with extensive computer print outs containing excess information or material not relevant to their responsibility.

Figure 26 [37] shows an information flow chart, the basis for an MIS for a company based on input from a budget, input from the accounts department and input from service departments. Each of the key operating departments receives information and comparison reports to assist their management. Exceptions from part of the reports as well as the net results, together with pointers to corrective action, are also fed back to the general manager who decides whether further action is warranted in a department or whether the budget itself should be amended. Although corrective action in a department is the normal procedure, a sudden unpredicted change in economic climate can make a major review necessary.

The general manager needs to see that the following administrative procedures apply to make sure the MIS is maintained and provides useful information.

1. Overall results are being reported to key executives.
2. Sales, production and financial data including actuals and budget items are being supplied to these departments
3. The latest master planning budget to which senior people have contributed to be in their hands
4. The data entry clerical staff to be up to date and reports sent out on time
5. The budget program's software review including a check on accounts categories is up to date
6. I.T services, equipment, software and staff skills throughout the firm to be effective and compatible as far as possible

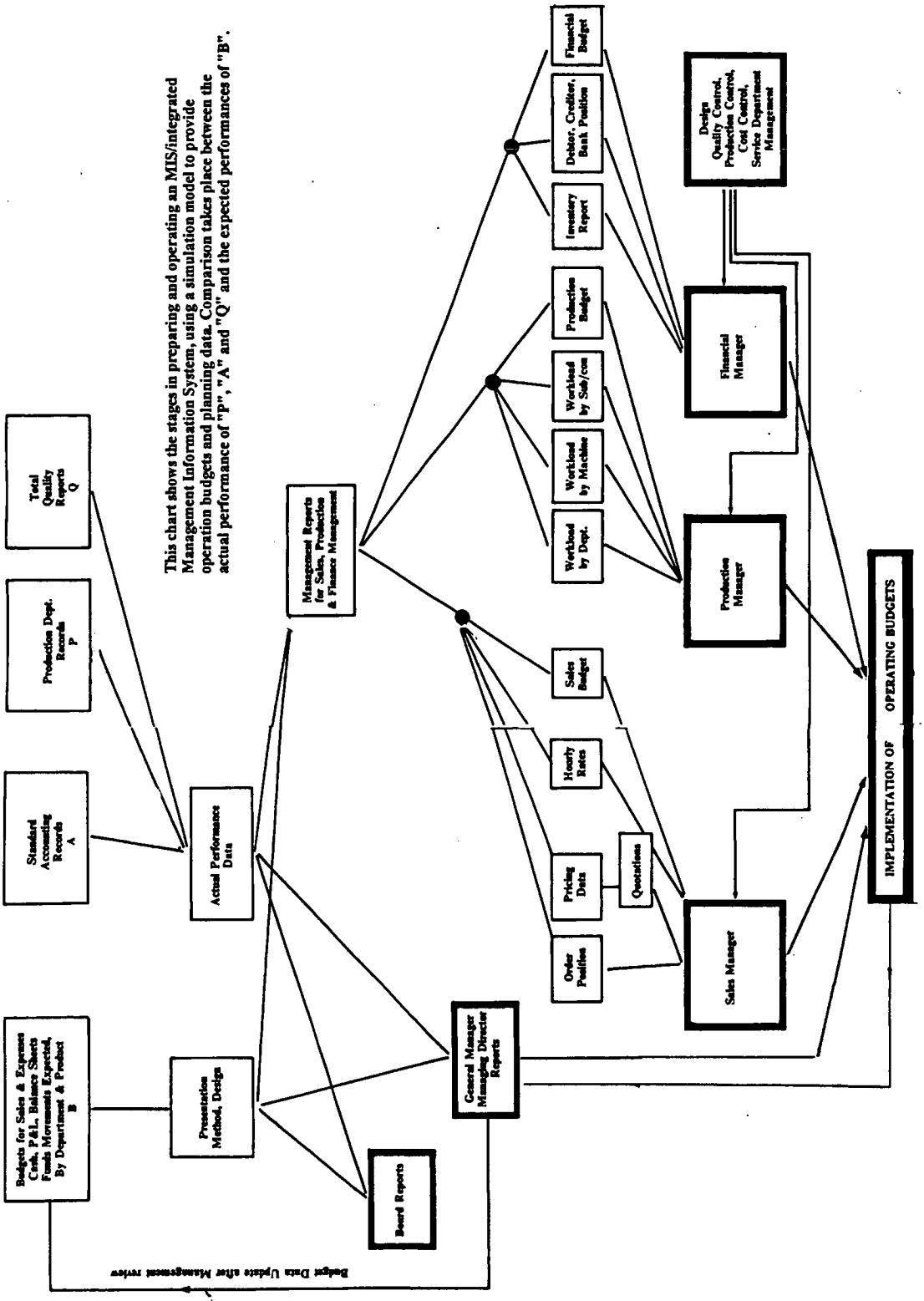



**Figure 26 Flow chart of an MIS showing the distribution of operating information to management to assist decision making.**

While the main items to be reported are listed above there are items such as critical ratios to be reported including liquidity, debtor, creditor and bank position and forward orders held. There are also items which are important to a particular industry or commercial concern. Such items as stock turn, profit to sales, gross margin, gearing, staff turnover and the extent of complaints are in this category.

### 2.8.2.2 Implementing an MIS

The above priority list applies to the overall control of a system already running. To introduce a system of this type, based on a simulation model such as that described in chapter 4, to assist executives define a budget, the priority recommended for development starts with clarifying the data required for the budget model, item 3 of the list in section 2.8.2.1 above. One then proceeds to work on items 2,1,4,5, in that order, bearing in mind the importance of item 6, to develop the MIS.

Items 1,2,3 and 6 may be available in some form already , ranging from occasional summaries on planning boards to sophisticated clerical processing operations. Calculation methods may include time studies, work sampling, adding machines, standard accounting programs, sales and analysis books and bank statements. One should not underestimate or necessarily replace current information but organise the data bases so that they are not duplicated, are cohesive and produce accurate coordinated information based on the data available. The information should be slanted towards improvement and not lead to so much information that the person receiving it is subject to an information overload which inhibits performance.

## 2.8.3 INFORMATION TECHNOLOGY (IT)

The extraordinary growth of this technology could be considered to have a threefold impact on business and the community. From a business stand point there is first the internal effect on communication and management and second the impact of the external environment due to the way messages arrive and are transferred to others locally and internationally. The third effect, is the impact on each of us as individuals, and consequently as staff members, due to changes in media contact brought about by newspapers, television, internet and e-mail techniques, mobile phones and globalisation. While this latter impact is very important, since

we need, due to this, to approach a firm's human relations, cultural awareness and skills with new insight, it will not be dealt with in detail in this thesis although it has clearly coloured many of the management approaches outlined here and advocated for managers with an engineering background.

To appreciate the extent to which information technology impinges on most businesses the following list shows the main areas of data processing and the use of computers to correlate management information and promote process improvement in general. Data processing can assist decision making throughout management as well as stimulate the service departments to present information to line management in a way that promotes improvement. Computers do not make decisions but often they can rapidly change data into information in time for staff to take action. People are needed to make and implement the improvement decisions.

#### 2.8.3.1 IT applications

**Standard clerical processes** Invoices, statements, debtors, creditors, payroll and general ledger requirements together with word processing, letters and promotion stationary are in this category. The ability to correct and restructure written material is not only made easier but in many cases has changed the office responsibility of those doing the work. Pricing and production planning calculations have been revolutionised using software again using inexpensive computers for this purpose. Of all the business changes made using computers this area of office clerical work has been one of the most significant as far as savings are concerned. Now we have the further advance through mobile phones, fax, e-mail and web presentation, of replacing a large portion of the letter writing, phone and typing required for communication. At this time we are only just learning to balance the use of each of these services with our own ability to store messages and act on them at the rate they are received, and yet still be able to concentrate properly on other pressing questions needing solutions.

**Management information** An MIS to assist management decision making collects data from various sources and changes it into compact information for decision making by production, marketing, financial and service executives. Review of this information at

meetings is described in some detail in chapter 2.7.3 , and discussed in chapters 2.8.2 and 4. Aspects of this process are required in some form in all businesses.

A new era is now opening up in which industry focused software packages are becoming available to display operating information, such as process throughput, waste, critical temperatures and pressures for each section of a plant. The plant items are often shown on the screen in three dimensions and in flow chart form to allow several department supervisors in different geographic locations of an interconnected plant or mining operation to work together to manage the balance required between the various parts of the process. One of the dilemmas encountered by software developers of this important type of package, and holding this development back, is which operating system to base their work on at this time when operating systems are continually being updated as a marketing technique.

**Efficient calculation** The need for efficient calculation of research data to ascertain probability of a correlation between sets of data from experiments and the analysis of past sales records to assist projections into the future are examples of cases where computer calculations involving many iterations are needed. Recently mathematical analysis within areas of operations research, genetic algorithms, and fuzzy logic associated with perceptions have benefited from the extraordinary capacity for calculation now available from office computers. The important thing here is that the time saved through the calculation process can be spent on interpreting results, planning experiments, literature studies and examining the impact on society and industry of the results of the calculations.

**Process control and design** Applications of this type include CADCAM in which three dimensional designing can be carried out and, when finalised, translated into shop drawings or provide signals to numerically controlled machine tools for direct production. Another example is direct process control in which measurements of important criteria are transferred by signals to controlling software which takes action if the measurements are outside say 3 sigma limits rather than respond to every change. Project planning in the construction industry is another application of this type in which the critical path and the presence of any available free capacity to assist critical path limitations needs to be continually under review.

**Consumer product components** Many consumer products and services have, as part of their permanent operation, built in computer chips installed with specific customised instructions which operate when triggered by a signal from the consumer. They include cars, lifts, traffic signalling, security systems, microwaves and washing machines for example. In many cases they replace mechanical and traditional electric controls and since their inherent software is rigid they can only be repaired, updated or debugged by complete replacement of the printed circuits or chips involved.

### 2.8.3.2 Computer hardware and software

Computer hardware is the physical resource able to rapidly process a wide variety of data and process that data to produce information. The processing can vary from simple arithmetic calculation to advanced calculus. On the other hand computer software consists of control and application programs which detail and direct the execution of specific processing tasks within a particular item of hardware to produce a result.

The primary software is used to cause the basic chip and components of the computer to respond to instructions from specialist application software which carries out a specialist task such as word processing or a simulation program to provide the budgets of a company. To present results on the computer screen in a "user friendly " fashion an additional third type of software can be employed which accepts the answers from the application software and places them in an acceptable or traditional form to promote action by an observer.

A further application program, referred to as a spread sheet and largely subject to custom made software referred to as a macro can be used to assist in the assembly of data and provide easy update ability to a set of data matrices which can in turn be entered into a main application program. Having been processed the result can be passed to one or several computers in a different or the same location. The transfer of a disc or file or a typed message by e-mail, by the web, may take place from a person typing in a message to be received by a local service provider by phone who uses an internet satellite system to transfer the message to another interstate or overseas service provider who then relays the message by phone to a

client local to that provider. The input can be in writing, a picture broken up into thousands of dots processed by a scanner or directly from a disc, although a substantial increase in computer memory is required in the case of picture transfer at each end of the transfer process.

**Hardware** Hardware and software cannot always be freely mixed so that those responsible for hardware choices need to be aware of compatibility before purchasing these items. Most business people choose the software they need first and then find compatible hardware. The design of the hardware causes limits in the size of each RAM (read only memory) i.e. the span of its processing that can be carried out at any one time. There is also the extent of total storage of past and present files in the computer's HD (hard disc). The capacity of these items has radically improved over the last decade until the typical office hard disc at this time can contain up to 10 gigabytes of hard disc information, the RAM can currently be 32, 64 and 128 mb and the central processing unit (CPU) is now typically 32 to 64 bits compared with 8 bits just a few years ago. In fact the current pentium office computer is now more powerful than an advanced research computer of two decades ago at less than 1/500 of the cost. The cost of this equipment has been reduced so far that the critical question now is the design of the whole system, its reliability and its probable life before further training and updating is required to cope with further software developments. The cost of the parts is now relatively small compared with the cost of the staff to operate it. Depreciation is often of the order of 33% for this type of equipment, not because it wears out, but because current software marketing techniques can make it incompatible with the input from one's suppliers and customers also subject to the updating process.

Summing up a standard computer hardware system is made up as follows:

- A central processing unit which has its own language requirement and cyclically executes instructions contained in software designed to suit that CPU.

  To enable single chips to accept a numerical message one of the procedures adopted is to use a binary numbering system based on 2 not 10. The number 9 in the tens system becomes in the twos system 1001 being $1(2^3)+0(2^2)+0(2^1)+1(2^0) = 9$

A system of gates which allow full or no current flow, i.e. a "1" or "0" action translate the input signal messages into the required total number of the binary inputs and promote the required response.

- An operating memory, RAM, to allow immediate manipulation of data
- A hard disc, HD, to hold files of data, processed data and application programs to be stored and accessed as required. An additional facility is needed for storing or taking out and adding to the computer further processed information , either in the form of a FLOPPY disc, COMPACT disc or zip drive..
- Plug in terminals for access by peripheral items such as a printer for recording in hard copy form the data in the computer, the mouse for pointing on the screen to particular action symbols, the monitor with its screen for showing what you are doing and presenting results and finally there is the connection to the key board with its typewriter and additional instruction keys.
- Monitor for showing your progress and presenting results. In lap top computers this can be built in to the lid of the computer as a light emitting screen.
- Printer to record in hard copy particular files chosen from the hard disc. Additional software to "drive" the printer is a vital part of the operation of a printer and provision of this software is an essential part of the installation of any printer.
- A mouse and key board to enter data and promote action, also needing software for the mouse to "drive" it.
- A scanner and back up zip device are also considered necessary in many installations
- Manuals covering the operation of the above including a description of the chief operating characteristics of each of the parts in this list together with statements of lack of "bugs" to the extent that this is attainable.

**Software** As already indicated, computer software can be classified as being of three general types. First the operating systems which are primarily the computer hardware resource managers. Because of marketing skill in continually creating new products, ostensibly to improve the immediate past ones, some suppliers have attained a market share such that the small to medium size business has little alternative but to adopt their operating system. This is further exacerbated by the fact that the source code remains a secret and one can only

purchase a license to use it. Windows is such a system. An alternative system such as Linex , has a known source code but the existing connections needed between hardware behaviour and the operating system, as well as the enormous inertia represented by the size of current of current usage based on, and feeding into, an existing system is inhibiting alternatives which would break this monopoly situation. To allow some programs, particularly those in a high level language, to be translated so that they can be interpreted by the language of an alternative CPU a compiler program may be used. A compiler is equivalent to an Italian linguist who knows German and English and is therefore able to transfer messages between people who speak only those languages. In this example, Italian is the compiler or host language, English is say Cobal or Fortran the object language, and German is the CPU's language.

The second class of software program is that of the general purpose tools such as editors, word processors, composing programs which enable an operator to perform a commercial task such as letter writing, magazine and brochure production, accounting, pricing , production planning and comprehensive budgeting of the type described in chapter 4. These programs are usually written in a high level language and translated into a special form to prevent copying. They are standard packages which are not directly alterable by the operator although some can be changed by a local provider. Following earlier versions which needed improvement they are now efficient and save many hours of work in the office although their effectiveness is dependent, like all computer output, on the input. Because of a history of suppliers rushing these systems into the market before final debugging there is some merit in working with the "second last version" rather than the latest. It is important to be aware that often these new programs are only compatible to a limited extent with earlier versions of the same program.

The third class of program is one of more specific applications in which not only data input varies but the program may be tailor made for a particular industry. An example is a program to provide a mining, smelting and refining company in the metallurgy industry. The computer program is specifically designed to feed a particular customer's need. Displayed on the screen are all the relevant processes and real time information is gathered from each phase of the plant's progress so that executives observing the screen can adjust their part of the plant to

suit the whole enterprise even though they may be physically in quite separate locations. This is a very valuable use of computers and we will see a lot more of this type of program on the market in future including versions of budgeting and simpler production planning programs only applicable to a particular firm.

**Some operating comments** People working with computers such as programmers, data base managers, prepress staff and software designers need to know how to operate the system and the function of each of its components. They should know why the system is configured as it is. They should also be aware of the need for back up of original and current programs and the importance of labelling the back up discs, information files and copies of programs and where manuals can be found when necessary. Some observations on this question are:

- Some critical back up files need to be kept separate from normal facilities for security
- Virus protection should be continually updated and operating on all computers
- Know the order and basis for connections to ancillary equipment
- Encourage staff to be flexible in their duties and versatile concerning the activities of the computer room
- Have back up units, even a complete spare networked group, and install electricity surge protection..
- Check connections and cables first, should a computer or a system fail to perform.
- Arrange for regular disciplined meetings, with minutes, between designers and programmers when developing new software.
- Check that proper seating, the height of equipment and appropriate lighting and heating apply in the computer room. It may be necessary to regularly interrupt some data entry work and word processing with separate secretarial activities such as copy proofing, photocopying, thinking out what to do next, filing of past information or a leisure break.
- Remember that a computer screen does not think out the solution to a problem, since the computer is only a tool administered by a person. It is therefore necessary sometimes to leave the computer work station and proceed to an alternative to gazing at a screen to solve a business or research problem.

## 2.9 QUALITY, PROCESS CONTROL, RESEARCH AND DEVELOPMENT

### 2.9.1 Overall Quality Control

#### 2.9.1.1 Defining quality

Quality as an overall target for a firm, requires consideration of the whole enterprise, its customers and all those who produce the firm's products and services including suppliers. If we take the view that quality is a relative consideration in the mind of the customer then the price paid relative to what the customer gets for their expenditure in also important. Clearly completely unsatisfactory products should not enter the debate over quality. However criteria such as the length of a product's life, the effectiveness of its application, the follow up service available, its appearance and the price are all important in the average case.

Design to meet the market's need at the price the market is willing to pay is the first consideration. Not only does the design have to satisfy the customer but it also needs to take into account the manufacturing processes involved in its production so that it can be economically produced. Then there is the need to see that the defined processes for its manufacture in one's plant and in a supplier's plant are in fact being carried out - part of an "assurance" process. Of equal importance is the need for a positive approach by management to preserving a balance as far as quality is concerned. Finally quality, in the full sense, depends on people and their communications throughout the whole plant from board members to dispatch and reception, not just the responsibility of production personnel. Quality depends substantially on the budget process and the implications of the budget's allocation of wages for infrastructure, investment in process, sub-contracting, prices and terms of trade. These items and management attitudes are critical to quality, and determine whether a desired quality standard can be realised.

Many of the proprietary symbols in the literature about quality apply to aspects of the total picture presented above. There is TQC, total quality control, which really is a total concept involving customers, management, process, suppliers and company productivity. Then there

is QA, quality assurance, concerned with the customer - supplier relationship and their desire and ability to work together. Quality control, QC, on the other hand works largely on checking that standards, largely defined within the manufacturing plant, are being applied and involves checks on whether a department's processes are working within the limits defined in the standards. TQM refers to the management of the whole process which is part of TQC. TQS., refers to a total quality system, structured so that the infrastructure required to allow quality management to operate efficiently, including feed back from customers is in place. Another term used is quality function deployment, QFD, in which the customer needs are designed into the product and then followed through into detailed execution at each work station in the plant.

#### 2.9.1.2 Quality Index

In an endeavour to bring quality measurement on to a quantitative basis the author has pursued several avenues to this end with the help of university special project research theses. [38] [39] The principles established by A. Long and P.de Guzman set a pattern for N.Sarris and R.Dixon in the later research. The measurements taken to determine a quality index involved three principal areas affecting quality. These were respectively measurements of customer's views, measurements by people in the plant and finally moderating measurements by management who appraised both the effect of economic factors and the ability of plant personnel to make an assessment. Software was developed to provide a final quality index, such as 80 out of a possible 100, as a measure for future comparison and positive action if required. The appraisals highlighted where weaknesses and strengths existed in the quality approaches and training throughout the firm and in particular the results showed where important differences existed between a customer's quality views and the views of those producing the products in the plant.

One of the most significant findings was the effect on the management appraisal of the state of the economy. In a buyer's market the customer's view received more emphasis while in a seller's market the manufacturing plant tended to receive greater recognition. However this did not stop quality being identified by a useful index number in both cases.

The first approach, that adopted by Long and Guzman was based on a common measuring target for both customer and an in-plant department person, concentrating on the main activity of a department. Examples of processes assessed by this method would be welding, machining, assembly, painting and packaging. The second group Sarris and Dixon considered that the customer analysis part of the index calculation should be based on items the customer is more likely to recognise without knowing the details of the process. An example of this approach is for customers to measure their quality appraisal in terms of appearance, function, maintenance, life and cost. It is clear that both methods are useful in particular cases. Even better the customer's observations need to be translated into the in-plant criteria affecting their quality view points and this translation should be part of the software. This index, calculated using simple software, provides an insight as to where quality can be improved. As mentioned above an important observation was that a quantitative assessment of "quality" depends on the economic climate in which the firm operates and the effect of economic policies as interpreted in a firm's budget and its strategy for the future.

### 2.9.1.3 Quality standards

Australian quality standards have been established to encourage action throughout industry to recognise that quality is a key issue in the production and marketing of goods and services. The ISO 9000 series is designed for this purpose, first to improve and maintain quality standards and second to enable accreditation for firms who comply, so that they are given a competitive edge in the market place locally and overseas. The approach advocated is excellent as far as plant improvement is concerned particularly through its insistence on having a sound management structure as part of quality production. One concern needing moderation is for the potential of management through its marketing people to use initial achievement of accreditation as the only aim rather than the parallel need to continually monitor and maintain quality standards. Another area to be watched is to see that both customer needs and a board's financial policies supporting quality improvement are sufficiently fed into the process so that accreditation is not assumed to be attainable through factory methods alone.

The initial stages of the standards introduction emphasise the need for proper management, a practical organisation chart and delegation of authority. Job descriptions are advocated, together with an effective cost measuring system and carefully defined process control procedures with raw material input carefully specified. Selection of the right people for each activity, efficient production planning and having sufficient technological wisdom to run each process are also implied. These preliminary requirements of the ISO 9000 series simply mean that a balanced and properly organised management, fully behind a continuing quality nurturing and awareness policy, is an essential starting point for a quality program of this type, as it is for success in all modern industrial and commercial activity.

These standards have associated external auditing procedures to check on the firm's documentation and defined process control activity to see that the defined procedures are actually taking place and justify continuity of accreditation.

### 2.9.2 Process Control

Process control has traditionally applied to a factory's direct supervision and advisory services to keep a process and its products in line with a specification. This can apply to a whole series of processes in the plant and to geographically isolated departments of an enterprise needing coordination. The control can be by an electronic or mechanical motivating device as explained in chapter 2.6.3 and figure 23, using amplification and feed back or by a staff member providing advisory service to a line supervisor.

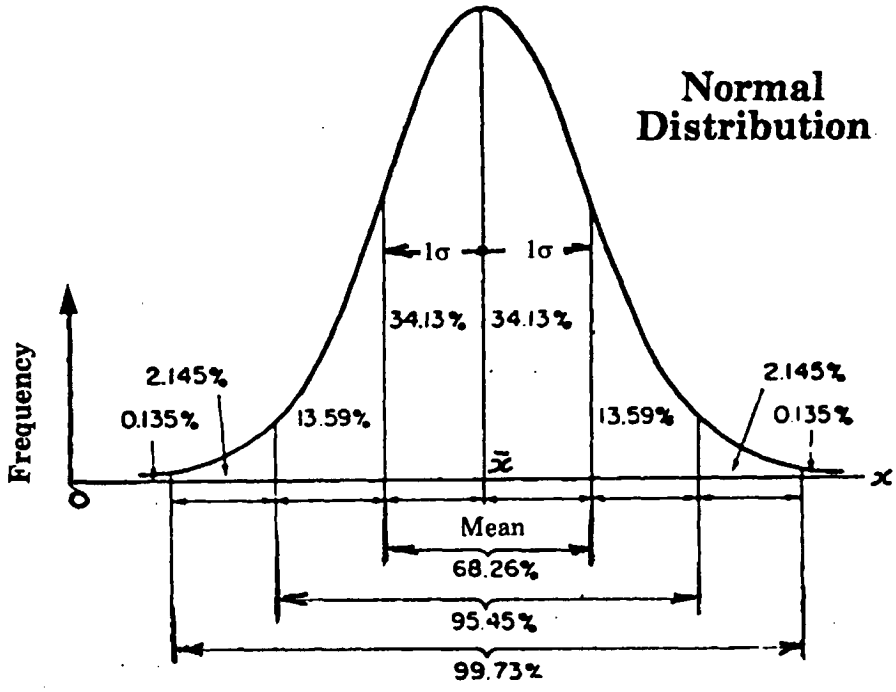
Recognition of the needs of two different industrial supply situations can assist in the design of an efficient process control activity. First is the case where the raw material can vary from batch to batch in a way that can cause a need to change operating criteria in the plant to be in line with the current raw material used. Examples often apply in industries using natural organic and mined materials. Processing of rubber, oil, textiles and raw minerals are typical of this need. To meet this need laboratory services first evaluate samples of all raw materials entering the plant and inform process control staff throughout the plant of guidance they need to assist the production supervisors. Any changes needed to technical processes required to

process the raw materials are pointed out. To operate the management of plants subject to this need requires a clear understanding between the process advisers and the line people as to the responsibility of each. Selection of the process advisers is therefore very important, they must be skilled technically and have the ability to get things done through others on a continuing basis, often regularly working in the same factory area as the supervisor of the department's labour. Strong leadership and top management authority of the overall process control department is therefore important, to enable this department to stand up to production staff on occasions where major safety and quality considerations apply.

Second are the many cases of direct control of a specific process. As explained in chapter 2.6 and referred to in figures 21, 22, and 23, the first step in control is to define the norm, the desired target, the standard or reference point. This can be a temperature, pressure, a flow rate, a size measurement or a production quantity. Next step is to define the limits which are allowable above and below this standard. Action to control can take place through personal attention or by automatic control of the process at a control station using instruments connected electrically to a part of the process. This is particularly important in the case of chemical production flow processes such as production of concentrated sulphuric acid in which a sequence of operations on a flow line may need adjustment from time to time.

It is a waste of executive time to chase exceptions to a standard based on limits, for the purpose of pin pointing corrective action, when the variability of a system is outside those limits. Action is first required to reduce general variability so that when a real abnormality occurs the limits chosen make it worth while trying to find a cause to hopefully fix the problem. Measurement of inherent variability can be carried out using mathematical statistics. Following calculation of the mean, (the average measurement), the difference between the mean and each measurement is determined irrespective of whether it is negative or positive. The standard deviation of results from the mean is the square root of the mean of the squares of all the differences from the mean. The use of standard deviation can be illustrated using a typical "normal" curve of all results as shown in figure 27.[44] If the area under this curve is regarded as 100% of all results then the area corresponding to the span of 2 standard deviations contains 62% of results and 38% of results will fall outside these limits by chance

alone. If limits had been set on this basis then 38% of the results would be investigated for an exception even though they are only part of general performance. On the other hand if the limits were set at a span of 4 standard deviations the area under the curve is 95% of the total and chasing the remaining 5% for abnormality could be economic. In the case of limits set on the basis of a span of 6 standard deviations there is a 99.7% probability of finding an exception and hence a much more economic use of process control time would be involved.




$$\sigma = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n}}$$

**% = Percentage of area**

**A span of 2 sigma includes 68.26% of the total area**
**A span of 4 sigma includes 95.45% of the total area**
**A span of 6 sigma includes 99.73% of the total area**
**where sigma is Standard deviation**
**and n is Number of observations in total (>30)**

**Figure 27 A "normal" distribution curve, with the area under the curve representing 100% of the data, indicates the proportion of data which falls outside 1, 2 and 3 sigma limits distant from the mean of the data, by chance alone.**

A measurement of deviation can be short cut by using a sampling technique and plotting the sample's arithmetic difference extremes regularly on a chart as part of shop floor responsibility. In this case with deviation limits also shown on the chart, an immediate visual indication of the degree of control is available to promote action.

### 2.9.3 Research and Development (R&D)

Research and development takes different forms as one moves from what may be referred to as pure research on the one hand to direct improvement of a product or process on the other. This division, as far as most Australian companies with engineering capacity are concerned, leads to a division of responsibility as to who in our society, with its limited market, concentrates on each of these activities. The limitation on pure research is the time factor. As an example it can take 5 years to move from an idea to a prototype and at least as long to learn of the market's reaction to the products produced. Since many research groups and businesses can not afford to wait that long for a return on their investment in the R &D process they look to government support for a proportion of the funds required to carry out their development work. The government's logic is that ultimately part of the research may be capitalised and result in increased profits and employment and their contribution will give rise to additional taxes in future to reimburse the community for its investment. In the case of the universities a grants system operates in which contributions are made towards research programs to allow a valuable knowledge base, at the forefront of world advances, to be established through the research students and their supervisors who participate in this process. Recently CSIRO has moved more towards shorter term results and participation projects and encouragement of the Intelligent Manufacturing Systems, IMS, program of coordinated international joint research ventures and CRC, cooperative research centres, involving groups of local companies. Then there are the very important individual company efforts, which could be largely classed as development activity and range from the larger firms with an individual department to smaller concerns with an accent on continuous improvement often tied to a quality responsibility.

The principal sources of research and development for the production of new ideas and ways of competing are considered to be the following:

### 2.9.3.1 Research by universities, government and semi-government groups

University engineering faculties undertake ongoing projects in which a staff member with particular knowledge in that area is developing further knowledge and understanding by personal experiment and by providing supervision and guidance to research graduates. The motivation to make new discoveries arises from a combination of the researcher's training and a strong desire to contribute to new knowledge. Sometimes the career prospects of the researcher depends on the refereed papers published as part of the research presentation process. While the papers with this new information are mainly published at international conferences largely for universal reference and the benefit of attendees at the conference the conferee has their paper appraised and develops their expertise through conference contacts. In other words the participants give and receive information in this way at this specialist level.

As there are far more submissions for grants than acceptances there is intense competition for grants and this tends to limit acceptance to on-going research fields, and may not involve commercial aspects of technological advance. The benefit to Australia is the provision of informed professionals in a wide range of fields able to feed the new information back into the community and provide a signal as to where new advances and discoveries have taken place. This valuable knowledge base in university staff and their participating students not only provides international prestige for Australian applied science overseas but plays a part in dissemination of advanced technology through contact with industry and by providing industry, through tertiary education, with professional engineers.

It is the author's view that the above contribution is an extremely valuable and important one. However a major R&D gap in Australia exists in which marketing studies, innovation, technology and commercial application is not a predominant part of research funding in many instances. Probably because of limits placed on the funds available, demands on teaching and research time, debates over intellectual property rights and some reticence in dealing with the

commercial world, there does not, in general, appear to be positive support through university grants or from many university engineering lecturers for direct industry involvement.

CSIRO has made a major contribution to technological development particularly in the agricultural industries together with state government extension services. Improvements have been the result of both original research and valuable liaison services with farmers and government service groups as well as field days. Building industry research and provision of material strength standards have made an important contribution. Mining has received stimulus from both technology research and joint development projects. The standards association has helped with improving industry and customer communication through its meetings and emphasis on uniformity and quality criteria. Over the last decade CSIRO has provided important leadership and assistance in promoting manufacturing improvement and international encouragement for the "Intelligent Manufacturing Systems" program and local technology improvement. There has been a culture change in CSIRO over the recent decade which has resulted in more accent on the manufacturing part of the "I' in CSIRO but it could no doubt do with a lot more financial support in the way agricultural research and development received funding in the past.

One of the questions frequently raised by financially pressured administrators of our universities and government funded research groups is that of intellectual property. To augment their income these organisations consider that they create a marketable product through their activities ranging from export education to the right to have licenses or patents over their part in a development. This can be restrictive as far as the flow of information and initiative are concerned. The pace of economic change, in a user pay era , the need for an appreciation of the risks involved by both a research institution and its industrial partner, and the difficulty of assessing returns long before any tangible benefit is obtained, are all limiting factors to arriving at an agreement to proceed. Add to these considerations are the desire by industry for exclusive rights and control of market share of the research benefits to enable them to recover their investment, and the common industry view that salaried people in research groups are paid by the government to serve the community and should therefore be available on a sub-contract basis.

Cooperative research centres in which research organisations and industry groups participate and share benefits are one practical approach to this technological development need. Another method is for the university group to offer to provide development opportunities through a research student working on a firm's need with close liaison by the firm's staff representative and supervision by a lecturer. The lecturer, the student and the firm's staff all benefit by this process. Having confirmed that this type of liaison provides benefits and having established how to work together, the firm and the research group then have the confidence to enter into a more specific longer term liaison on either intellectual property, or a grant by the firm to encourage future research. However some measure of career recognition for participation in this process needs to be given to the researcher for this procedure to be more widely implemented.

#### 2.9.3.2 Direct industrial research and development activity by companies.

The first principle a company needs to adopt is one of continual improvement quite apart from any dramatic development. This is achieved by individuals and groups at the shop floor receiving encouragement to meet, exchange ideas for improvement and analyse reasons for short falls in production and quality, and plan action to alleviate weaknesses. The senior levels of the firm need to keep in touch with shop floor comments and operations, follow up on leads from the literature, and make overseas visits to check technology advances. This can take place through conference attendance and liaison with international equipment and process vendors including attendance at working demonstrations of their equipment in overseas plants. While knowledge of one's local industry may not reveal the opposition's future plans there needs to be at least an up to date knowledge of the general technology and commercial approach currently operating in one's industry and why it is structured that way.

Training of staff at all levels is probably the next most important action needed, first in a specialty the firm needs and second by stimulating and broadening the approach of a staff member in something which both interests them and at the same time contributes to their ability to communicate and assess needs. Overseas travel with an important objective is an important catalyst in this respect. Staff should be encouraged to suggest training

opportunities and arrangements should be made to see they come about whenever this is possible. This last need is particularly important when a new technology is being pushed in the market place and insufficient knowledge about it resides in one's firm. Rather than be precipitated into a buying decision without sufficient information every opportunity for obtaining facts should be pursued. One of the best way to find facts about a development proposal is to carry out investigations oneself by investigating both the customer and supplier position and by carrying out development by making a prototype in one's own workshop. The conventional research approach is one which follows the formation of an idea with an experiment, then a prototype or batch, and finally a production run in which the reaction by agents, wholesalers, retailers and customers is fully ascertained. It is not generally realised that this process can take many years since the background to this approach is an extremely thorough one in which little risk is taken at each stage of the process before advancing to the next stage. On top of this the marketing or commercial stage to develop the process further can take as long as the whole of the technology advance stage.

In the current global economy a procedure involving risk assessment is adopted by many of the highly competitive companies, particularly in U.S., to overcome this time factor and not be left out. They carry out investigations in their laboratories, get as much information as possible by internal trials, carry out some market trials on a small scale then rush the results of an initial investment into the market. The next stage is to learn from the mistakes they identify through this process. Far from giving up and blaming the judgment of their entrepreneurial staff they take such action as, for example, as doubling their next investment in an improved process having found what will satisfy the market economically, way ahead of their competitors. They now have a dominant position in the market and can charge a premium sufficient to recover their total investment quickly and when the opposition finally gets into the market they drop their price to make it extremely hard for competitors who have adopted traditional research methods uncoordinated with investment strategies which take risk into account. Figure 28 [37] illustrates this situation using three cases in which the effective capital required is substantially reduced by taking risk into account following preliminary R&D. The author has taken part in a form of this accelerated entry into a market with a new process. Initially there was market and technical appraisal and trials of what to do to meet a

new opportunity. It was then found that a complete plant could be bought from overseas with proven performance in the field without having to go through the costly and time consuming second half of the development process. Even the finance for the complete plant was made available by the overseas country's export finance facility spread over the expected time to recover the investment because the supplier considered we knew what we were doing and had done the necessary R&D to understand and run the process.

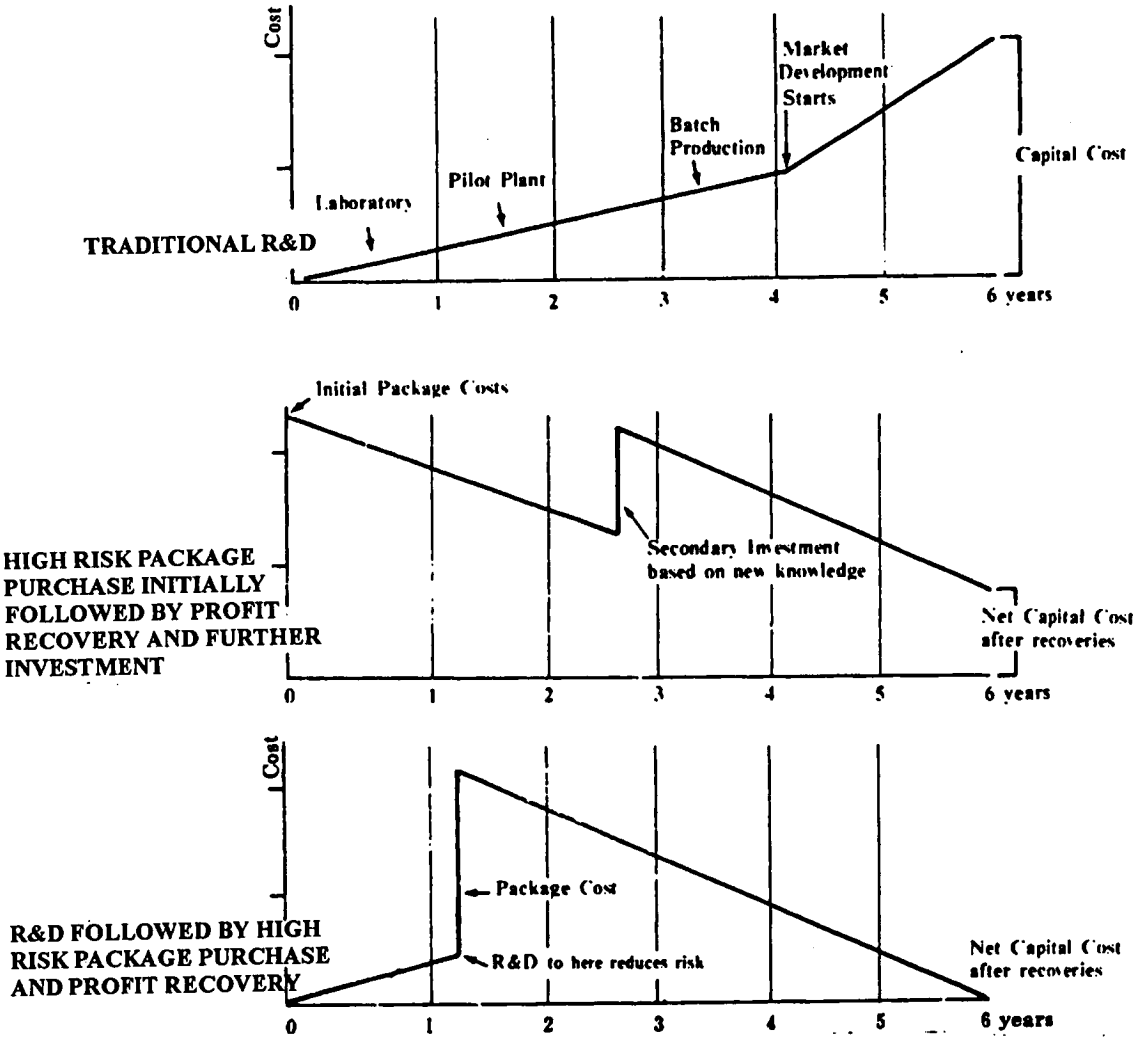



**Figure 28 Three types of investment approaches showing how R&D can be combined with investment policies and risk analysis to reduce net capital expenditure.**

Another research procedure adopted by some highly competitive large companies is to carry out research on their supplier's products so that they have patents or knowledge which

prevents their suppliers charging too much. Development by R&D of an alternative method for producing a supplier item can have the same effect, that of keeping costs reasonable. Most engineers having a knowledge from their training that "action and reaction are equal and opposite" will appreciate this latter method of remaining competitive, that is, not by confrontation, but by producing an alternative equally effective process or technology to that of a competitor or supplier.

#### 2.9.3.3 Library of relevant books, periodicals and reports

The knowledge base of the organisation is in both the staff and the company's records. The records need to be kept up to date and in a readily available form as part of the firm's capital. Borrowing needs to be easy yet methodically recorded and information grouped in a way that encourages reading and note taking. The new technologies, such as computerised information records, interlibrary and internet accessibility as well as copying equipment are all important. Records, and their methods of access, need to be coordinated with other parts of the business such as accounts, planning, quality control and IT departments so that the software programs used are coordinated and staff skills to operate them are readily available should staff changes take place. Regular review of the periodicals received should also be carried out.

## 2.10 DESIGN, CADCAM, ROBOTICS AND MAINTENANCE

### 2.10.1 Design and CADCAM

#### 2.10.1.1 Design - a comprehensive activity applicable to products and a whole organisation

Design is a term which involves the inside, the outside, the method of construction and behaviour in the market place of products and components, and in fact the organisation and image of the whole enterprise.

In the first place a product should be designed to meet a customer's need but since the cost of production may lead to a price which is too high for the customer, the method of production and capital investment required must also be a design consideration. In addition the life expectancy and maintenance requirements of the product are vital to long term satisfaction and continuity of the market for customer, retailer and manufacturer. Finally, irrespective of a product's performance, the appearance and packaging associated with the product also play a part in marketing and the customer's perception of performance.

Consideration of the detailed design requires an examination of the function of each component of the product to assess its suitability. For example its strength and chemical constitution, having regard to the material selected for its construction, and whether a component is really necessary in any case if the design can be modified to eliminate it. At this point the contour of the component and the casting, forming or machining requirement need review to check the production processes required, bearing in mind the batch sizes liable to be involved in its production. The cost of making the component can be assessed using methods study to estimate the times required for production and hence the labour cost using an hourly rate.

The engineering and structural considerations applicable to the design are of course vital and should be part of the technical skills involved. What is emphasised here is the comprehensive nature of the design process and how it involves several departments within a firm as well as

its suppliers and customers and requires equipment and working capital needs as well as management support, to be taken into account combined with budgeting and general management action to make the design process successful.

Making a prototype using the proposed design allows the assembly processes to be checked for difficulty as to assembly of the product and its performance and whether it is easily installed in the situation where the product is used, for example within an automotive drive train.

Then there is testing under practical and relatively demanding conditions to check life and service needs. Sometimes maintenance costs can be radically reduced by designing preventive characteristics into the product at the start. Even at a higher initial production cost, the competitive advantage attained can be used by the marketing people to recover more than the extra cost involved. The procedures just outlined are aimed at producing a practical product, checking that its manufacturing cost and capital needs are attainable and can meet the restrictions of the market and finances. The next step is to check the aesthetic needs of the product, particularly for a consumer market, and the way it will be presented, its packaging, its name and associated advertising and public relations policies. Whether the product is to be part of a range of products available to purchasers may be important and in that case the selection of size, power and weight for example, could be critical to commercial success.

As indicated in the opening comments of this section, the concept of design also applies to the planning and structure of the whole enterprise, its constitution , its organisation chart and its management as part of its ability to fulfil customer and shareholder needs. The purpose of this thesis is to identify aspects of company design, the structure and management which engineers need to understand to complement their skills and enable them to implement improved management through better budget policy development and implementation as direct participants in senior management. By this process engineers can assist in the design of an organisation to make it effective. This action, as has been made clear in this chapter, needs a dynamic and much broader approach than that of a parochial discipline.

### 2.10.1.2 CADCAM and automated design techniques

The three dimensional image of a proposed design was until around thirty years ago largely built up in the minds of engineers, through their training in drafting, from a plan and side views of a device set out on drawing paper and this is still a useful communication and recording process. Computer science has now made it possible to build this projection and the details of the plan into a three dimensional perspective presentation of an object on a computer screen and this technique also makes it possible to reverse this process back into a set of working drawings.

This has enabled designers with suitable CADCAM (computer aided design, computer aided manufacture) software to view a proposed design as it will be, alter dimensions if necessary and then prepare a set of working drawings as a record and then directly down load the final solution to an NC (numerically controlled) machine tool for production to proceed. Additional signals can apply which define such items as gearing to produce the required speed of production of the machine, the entry of feed stock, the number of components desired, together with its feed rate and depth of cut having regard to the material being machined and the power available. Although the capital cost is substantial the ability to economically produce shorter runs, due to savings in design, set up and supervision time, can outweigh the capital cost and at the same time save working capital by processing smaller size orders economically. Strong liaison between the operator supervising production at the machine who feeds back improvements to the designer can further enhance the benefit of this process.

Control of lubrication and scheduled tool changes before wear causes out of tolerance work can apply to this technology, together with the use of sensors which tell of trouble and/or stop the machine when attention is required for maintenance, replenishment of stock or the end of a run. A further development of this process leads to combinations of machining processes incorporated into a single cell. The machine can select a pilot drill and following its operation return the drill and then proceed to select a larger drill to complete the drill hole and then ream that hole. This can apply to all the holes applicable to one casting which can itself also move to suit the process. In the case of engine blocks a major portion of the machining to

prepare the block can take place in one cell fed by a conveyor supply of raw blocks to the cell.

This technology has given rise to the need for a systems approach since when a fault is detected by a sensor it is necessary to isolate the cause and decide on priority between processes as to the fixing procedure. It is also necessary to recognise that investment and maintenance decisions for these processes need to be combined with both sufficient sales and the proper allocation of skilled wages for infrastructure, if these automated cells are to contribute to lower costs in long term. The management of this method of production therefore involves a comprehensive general management approach and careful overall budgeting of all facilities, rather than being solely a workshop responsibility as it was in the past.

One of the keys to automation is to have an adequate market and since the Australian market is small with its twenty million population and the need is for a market of around two hundred million people of suitable purchasing power we are forced to embrace globalisation if we are to compete on the basis outlined in the last paragraph and maintain our standard of living. However in the case of the less elaborate NC machines we can meet many of the local needs without having to have such large sales, particularly for a niche market, in which the designer and the producer can be closely linked and set up time can be minimised.

### 2.10.2 Robotics

Engineers have moved from an emphasis on such items as bearings, tolerances, stresses, fluid flow and thermodynamics to a business world subject to the pressures of marketing on an international scale, technology which is rapidly advancing and management in which the organisation structure of our businesses must encompass systems, delegation, investment and financial control as well as traditional engineering. [17].

As already discussed automation involves having a sufficient size of market to justify the capital expenditure required and a source of capital to allow production on that scale.

Typical of some of the market groupings on the world scene are the following:

| | |
|---|---|
| European common market | 300 million people |
| North America free trade area | 270 " " |
| Australia., Pacific, Japan | 270 " " |

If however the standard of living in a region is insufficient to support purchases of the type of goods we produce the markets are artificial despite the numbers of people involved. Potential clearly exists in the future in countries such as China with 700 million people, India 550 million and Russia 240 million as their economies develop. Also there are limitations, in the automotive industry some observers predict that only a handful of organisations will be required to fulfil the needs of the whole world by around year 2005 since the productive power of automation and robotics is currently outpacing demand in that industry. On the world's mineral markets the extraordinary productive capacity of a Canadian nickel miner is another example. In this case above ground control of underground mining robots can radically change the world's supply/demand position and affect business decisions involving robotic applications throughout that industry.

The robot needs very little manual labour, works almost 24 hours per day with no health concerns, long service leave or superannuation and does not necessarily need night shift supervision. It can increase safety and improve the consistency of the quality produced. It is however costly to install and needs new programs to motivate it to operate on an alternate set of tasks. It needs inspection and maintenance, supervisor training, commissioning and timing of its behaviour together with balancing studies so that it is compatible with other assembly line activity, for example entering the components into a printed circuit board or welding a car body on an assembly line. Since the precision with which its "fingers" meet the point of action in each instance is critical, the extent of back lash in the joints of say a multiple arm robot needs to be considered and locating devices designed into the object being manipulated to facilitate exact location. This can necessitate the provision of special optical sensors and scanning by geomatic cameras of an item on the production line to assist location. Once again robotics causes a movement away from untrained labour to capital management, marketing,

systems and skilled staff with specialist sub-contract component firms feeding robotic assembly, often from globally organised suppliers.

Lars Hvam [41] has emphasised how an additional function for the skill of an industrial engineer, previously applied to product design and methods, can be used to advantage if applied to a modern business and all its production processes. He points to the need by engineers to use similar techniques to analyse and improve the knowledge base of a firm including its systems for organising automated production. Two illustrations from Hyam's paper , figure 29, show an analysis process for studying "Product life" and another case for studying a "System" to improve it. This new era of robotic production and the pressures through technical advance and globalisation outlined in this thesis demand new management approaches and these need to be continually reviewed by such techniques as those suggested by Hyam, particularly when NC machines, robots and advanced cell systems are employed on a global scale.

### 2.10.3 Maintenance

#### 2.10.3.1 Maintenance policy and methods

Maintenance, as with many aspects of engineering, is now recognised as part of industrial and commercial management. Leading maintenance engineers point to the importance of designing reduced maintenance into a product in the first place. They also emphasise that the preservation of asset value is a prime task of the maintenance function, just as it is a basic target for accountants and general managers, in support of shareholder's interests and the long term security of a company.

There are two parts to maintenance engineering, the continuity of the existing equipment and processes and the improvement of those facilities. The latter invariably requires redesign and business action as part of overall management and therefore dictates that maintenance input is needed as part of business planning.

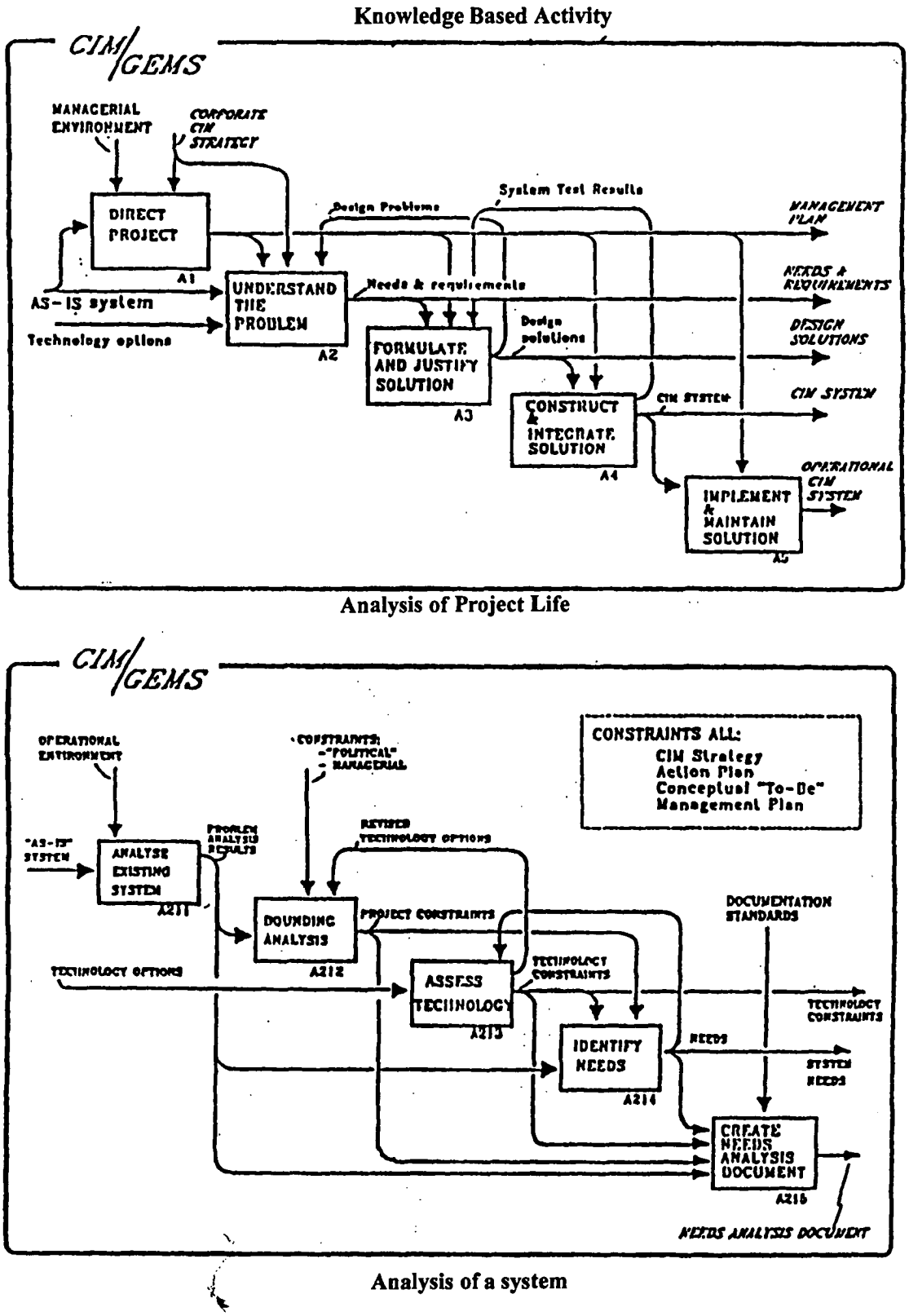



Figure 29 An industrial engineering approach applied to two cases of knowledge based activity, the analysis of "Project life" and analysis of a " System".

As David Clarke points out [42], there are three processes of maintenance, all of which include a basic philosophy of prevention of breakdown, reduction of the cost of operations and maintenance of asset values. He defines these as follows:

| | |
|---|---|
| Operation to failure | OTF |
| Preventive maintenance | PM |
| Predictive maintenance | PDM |

PDM has been rated as around half the cost per installed unit of power per year compared with OTF methods with PM costs roughly half way between PDM and OTF.

OTF is measured by calculating the cost of placing equipment back into order after failure. PM, preventive maintenance, based on schedules of inspection and routine replacement, largely on a fixed schedule basis with the back up of spares when break down occurs or inspection justifies this, is probably part of most plant maintenance where safety is not a factor. Irrespective of which approach is taken safety needs can override all other considerations by demanding replacement or complete overhaul well before the life cycle of the equipment or component has been reached. PDM has become increasingly important in maintenance planning using a combined statistical and commercial approach to assessing when maintenance action should take place. The principle employed is that of "condition monitoring". This approach looks at the probability of failure, and in particular the consequences of failure.* Consequences take into account the cost of loss of production including idle labour, abnormal replacement costs and loss of goodwill of customers as well, as already emphasised, of safety. In the case of process control equipment for example the effect on the quality and continuity of production can be very costly and an immediate response is imperative whereas the need to recondition a spare item may not be so urgent.

* An interesting example is that of the aircraft industry in which a major overhaul is scheduled followed by a complete pull down and replacement of any component out of its scheduled time or showing any sign of needing attention. The result is measured by the effective "time on wing", that is the flying hours attained under these strictly controlled safety and maintenance cost conditions. Because of the multiplicity of items involved this has resulted in substantial savings and a proud record of service to Qantas for example.

Clarke assesses the situation for maintenance engineers as their need to draw a balance between the maintenance approaches listed above. He sees a transition of maintenance from a "technical or service group" to a "business group" as these engineers play their part in management policy matters. In his opinion maintenance policy, as distinct from individual action, can no longer be fragmented among the various departmental leaders although they may need to take a part in its implementation.

#### 2.10.3.2 Maintenance auditing

The author has found that a valuable insight into the state of the maintenance requirements and deferred maintenance in an organisation can be obtained by carrying out a mechanical and operating (M&O) study on the whole plant. This study by an engineer aware of current manufacturing costs sets out in schedule form every piece of equipment in a plant. The company's asset register can be of assistance in this respect but the maintenance of this register should not be taken for granted so that all equipment needs to be actually sighted in the plant. The power and phase of the motors and switch gear required for each item is set down together with the names of the manufacturer of the machine and its associated instruments and controls. The mechanical state of the machine is observed, for example, back lash in its bearings, noise and vibration and the extent of its use in the plant. The speed of operation and output in units applicable to that industry and the quality of that output is recorded. Whether emergency spares such as belts, motors and relays are absent and their detailed costs are also included. Finally the estimated cost of putting the equipment into first class order is estimated by the observer.

The results of an audit of this type, particularly in a run down company or department can be a real stimulus to forward planning and result in an improvement in maintenance costs and management in general when the total cost of rehabilitation is faced by a positive board.

## 2.11 STAFF DEVELOPMENT, HUMAN RELATIONS AND WELFARE

### 2.11.1 Staff Development

#### 2.11.1.1 Specific industrial skills

Skills applicable to all companies range from those of literacy and numeracy to an aptitude in human relations and personal communication in addition to specific industrial technical and production skills. The selection of staff being of such importance will be discussed in the section below. While engineers, by their training and inherent interest are good at numbers and calculation, they sometimes need to develop their ability to write in a way that involves the other person and is not presented in the third person. They need to limit use of the form they adopted in many of their laboratory reports during their training. One aspect of the development of these skills is in being able to present ideas verbally at meetings and on a personal basis with fellow staff in a way that receives attention.

As with engineers, all staff need practice, and sometimes guidance and encouragement, in presenting ideas.

Of all the items needed to bring this about a major one is confidence and this can be developed by praise when this is due combined with provision of opportunities for participation at policy meetings. Chairmanship at meetings which encourages views from all participants to be expressed, is one method. Another way is the encouragement of group reading and debating on subjects outside the firm's interests. Taking part in the social functions of the company , such as the chess club, the golf club or helping with a Christmas function for the children of staff all helps but the motivation for taking part in these activities needs to come from the individuals themselves. Attendance at courses covering supervision and leadership where contact is made with others also striving to develop their skills in a range of industries is also valuable. In some cases personal counselling and in-house training are beneficial, particularly where there is an opportunity for practice. Overseas and interstate travel and contact with people from a range of cultures is important if it is combined with an objective which tends to open doors to overseas people with similar interests.

Two specific training needs are trade training in particular areas of the firm's activities at, for example, courses at a TAFE college and attendance at training courses for supervisors and potential supervisors in particular management skills, for example quality control, project management, supervision and leadership. Sometimes this is advisable simply to have someone in the plant aware of the language of a new technology so that wise decisions can be made about its use in future. The cost of this process is only about two weeks wages with, in most cases, a benefit to the individual in ideas and motivation which far outweighs this cost but the choice of course and the quality of its management is of course also important. There is increasing recognition that the knowledge base of the firm is as important a contribution to the capital of the firm as its fixed assets in this competitive global economy and this knowledge capital is increased by use of well chosen training courses.

In general in Australia, in the experience of the author, people are capable of more responsibility than they currently have at the operating levels in the plant. However this does not mean that there are not resistances within individuals to taking up opportunities when they occur. For example it can be too big a move for a rigidly trade trained person, taught to wait for orders, to suddenly be asked to become a supervisor and direct others as to what to do. The idea has to be introduced in stages with gradual increases in responsibility and training in the new opportunity. Some of us just do not want responsibility, some people prefer a single operating task rather than a broader function. Another resistance is a cultural habit of knocking the "boss" and a major shift in orientation may be required if that person is to become a supervisor. All these situations need recognition and formal or informal training to correct them. Professionals also are not immune from particular preferences which may need attention in order to obtain acceptance for an idea. An example is an executive who likes a bar chart or graphical comparison report as compared with another person who wants to see a list of exact figures to several decimal places before acting on information. Choose the method which motivates the individual.

One training theme that helps to address these needs is the use of an in-plant seminar for all staff on how the company organisation functions and how wages and security depend, in the

final analysis, on all those participating and taking responsibility in the firm. As part of this company wide approach is the need for training in financial management of one's affairs and the importance of cost control, carefully planned borrowing, investment and savings, both personally and as a company. It is not generally realised how important living within one's means is to both the company and the individual, and how much tension and poor morale of an employee comes from personal weakness in this respect. In a society in which the traditional structure of families is under pressure, wise personal advice, or help as to where to obtain advice, to individual staff members who are willing to air their problems can bring loyalty and increased harmony and efficiency in the work place.

The current accent by many tertiary training establishments on inflexible full time training only, rather than a firm being able to send an employee to an advanced course over a series of years, or to selected subjects, needs to be reversed to allow an easier method of advanced staff development for promising employees while they contribute to the company and earn a living.

#### 2.11.1.2 Decision making

Selection of staff and their development depends so much on their attributes that this is discussed further in section 2.11.2 below. It is important to recognise just how critical the initial appointment of a new staff member is in this context. We need to give as much thought, analysis and documentation to this process as we do to making capital expenditure decisions. If the staff we are trying to develop are not amenable to our organisation's standards of skills and objectives and have no desire to learn and innovate, we may be wasting our time later at the staff development stage.

Training in decision making is another source of improvement. Techniques to assist decision making such as factor analysis, decision trees, risk analysis and PERT/CPM,(described in chapter 2..7.2), are useful in coming to a specific decision but are also a valuable tool for training in assembling data and tackling any business decision. A factor analysis procedure is illustrated in figure 30 in which the key factors affecting a decision are rated out of 100% separately from any emotional attachment to the alternatives facing the decision maker. Each key factor is applied to one of the alternatives and the rating of that factor relative to that

alternative is also recorded as a percentage out of 100%. The multiplication of the two percentages for each alternative gives an estimated score for that factor for that alternative. All these results are added for each alternative to obtain a total score as a measure of which alternative is best. Clearly further analysis is required for close results but the weak alternatives can be identified and the reasons for a rejection is evident to those who proposed that alternative in the first place.

| | Importance Factor | Site A Melbourne Victoria | | Site B Coastal Tasmania | | Site C South East Victoria | | Site D South East Queensland | |
|---|---|---|---|---|---|---|---|---|---|
| **Description** | **%** | **Site Factor %** | **Total Points** | **Site Factor %** | **Total Points** | **Site Factor %** | **Total Points** | **Site Factor %** | **Total Points** |
| Water Supply | 80 | 50 | 40 | 70 | 56 | 70 | 56 | 100 | 80 |
| Market access | 30 | 80 | 24 | 30 | 9 | 50 | 15 | 40 | 12 |
| Timber supply | 90 | 20 | 18 | 90 | 81 | 80 | 72 | 70 | 63 |
| General staff | 30 | 70 | 21 | 60 | 18 | 80 | 24 | 85 | 25 |
| Maintenance and specialist staff | 60 | 60 | 36 | 30 | 18 | 65 | 39 | 55 | 33 |
| Transport | 70 | 20 | 14 | 60 | 42 | 70 | 49 | 50 | 35 |
| Site costs | 60 | 10 | 6 | 80 | 48 | 60 | 36 | 40 | 24 |
| Local Government assistance | 40 | 30 | 12 | 80 | 32 | 70 | 28 | 70 | 28 |
| Environment and pollution | 70 | 50 | 35 | 60 | 42 | 45 | 31 | 40 | 28 |
| Power | 40 | 80 | 32 | 95 | 38 | 100 | 40 | 70 | 28 |
| Total Site Points | | | 238 | | 384 | | 390 | | 356 |

**Figure 30 A factor analysis procedure showing some "importance" factors and their rating for a paper processing mill. Measures of these factors applied to each site allow preference details to be derived and a total score calculated for all four sites. In this case options A and D appear unsuitable while a final decision on the selection of B or C requires further detailed study.**

A decision tree of the type illustrated in figure 31 can be used to check alternative paths and compare the probable cost expected for each alternative stage of a proposed overall process. A choice can then be made as to which alternative to select. The principal questions to be answered in this case example revolve around whether an expensive trial should be authorised to test a proposed machine and harvesting method of extraordinary potential, but with new row spacing, on a relatively small scale first. At the same time the huge cost and hence financial risk of changing the whole arrangement without a prior trial and finding the machine is not the answer needed to be faced.

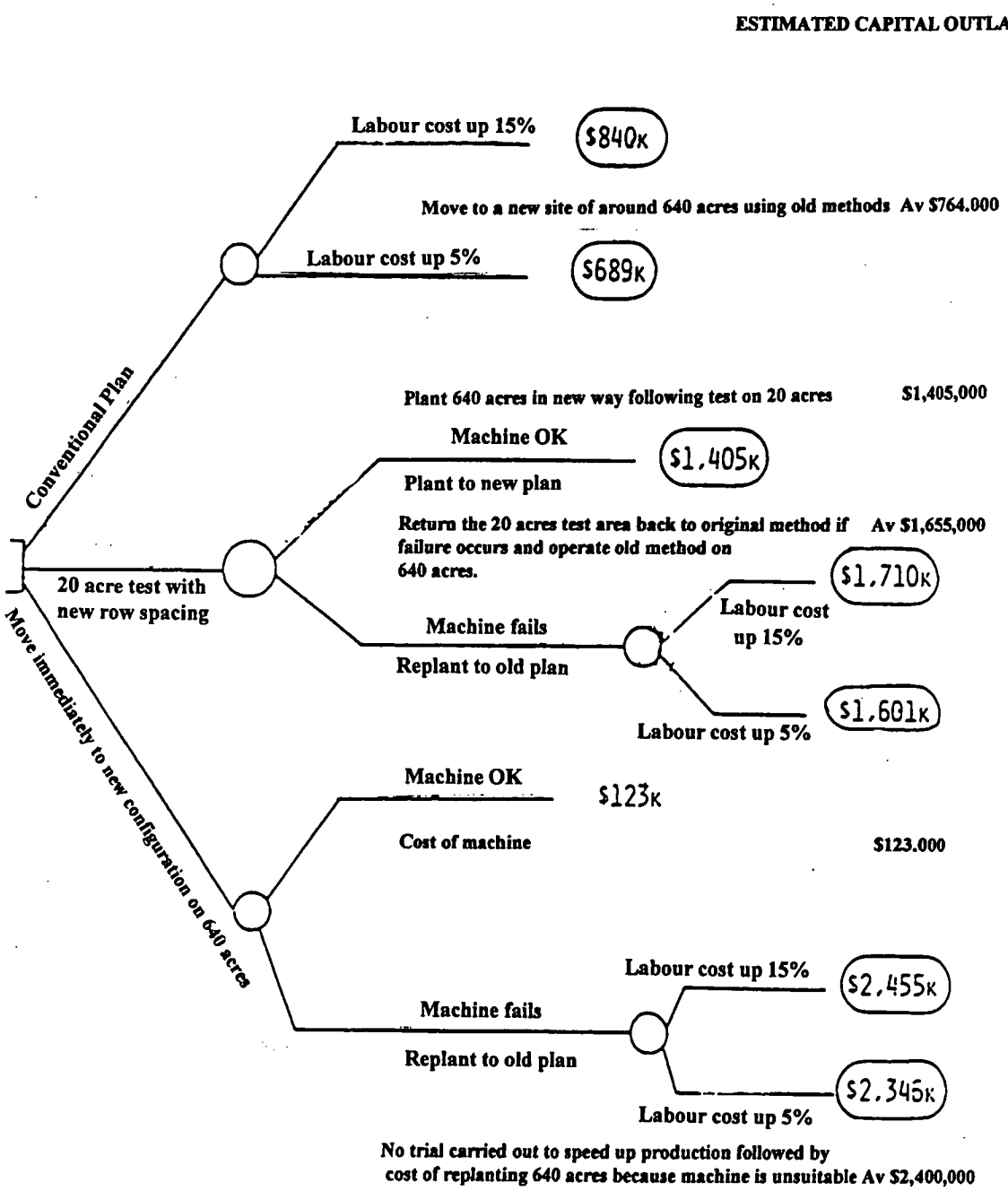



Figure 31 This case is of a vineyard faced with the question of suburban inflation and whether to buy a machine harvester to substantially reduce itinerant labour costs. Management wished to study the financial implications of the purchase, since the change will involve a very costly rearrangement of the vineyard's row spacing. A small scale costly trial has been proposed.

### 2.11.2 Human Relations, Industrial Psychology and Staff Selection

To put into practice the service departments of chapter 2.6, in which the transfer of information between people is so important, it is necessary to consider some features of human behaviour within a typical working environment. The descriptive language psychologists use to assist people in their relationships varies somewhat depending on the purpose for which the background information is intended to apply.

David Keirsey and Marilyn Bates [43] comment on the broader categories of extroverted and introverted types. They point to those who choose people and sociability as a source of energy as tending to be extraverted. Those who prefer solitude and working alone to recover energy tend to be introverted. In the case of family relationships, marriage stability and understanding children the approach may involve descriptions of personality types in terms of types of occupations such as architect, inventor, scientist, field marshal, journalist, author, seller, conservator, entertainer, artist, administrator, trustee, promoter and artisan for example. In this way they show how attractions and attitudes vary between types. These authors emphasise the importance of recognising ourselves and understanding just where our own approach fits within the total spectrum of humanity, and have set out a testing procedure to assist in this self appraisal process.

On the industrial front systems for generally assessing people's psychological characteristics as they operate in industry have been used for several decades. These systems are used by industrial personnel consultants to check for the suitability of an applicant for employment. They involve two sides to the process, that of the applicant's personality and gaps in the balance of the firm's personnel. This question of personality is additional to the technical and administrative skills of the applicant A breakdown of personality characteristics used in one of these appraisal processes within industry follows. In this process the three predominant characteristics of the individual are recorded from test sheets based on answers to questions that have been shown to be related to particular personality characteristics of people. The aim is not to reveal psychiatric abnormalities but define tendencies in normal mentally healthy people. This knowledge can show whether they will fit the particular need in a company and

how they may be supervised, motivated and disciplined to the advantage of all concerned. This method is a powerful process needing tactful application and integrity in its use. The following breakdown of characteristics is typical of a system of this kind, [26] complete with names chosen to identify each character type :

(a) Paranoid Type This person is forceful and proud. They can have a higher core value of themselves than their peers would allocate to them. They aim to maintain this image of themselves and need prestige and status. They can use words well and like to lead and make the decision themselves but can be very stubborn and aggressive on occasions. Tell them the facts with logical emphasis so that they can feel they made the correct decision.

(b) Hysteroid Type This person is material and money conscious. Financial rewards are very important to this executive. Can be flamboyant and ostentatious and appears selfish and can be shrewd and devious. Very conscious of input and output and short term returns. These people are important in seeing that sales margins are achieved as against those who are too generous to customers however they should not be able to have direct access to the cash movements without auditing in place. Commission sales can be a suitable motivation.

(c) Manic Type This person is the energetic, friendly, outward and people contact executive so often in sales. Is optimistic and likes variety and therefore easily distracted and can take on too many activities at the same time. Needs to be helped to concentrate on the main tasks yet needs continuity of outside customer contact.

(d) Depressive type Tends to be depressive at times in contrast to the manic type above. This pessimistic approach can make it difficulty to take initiative. He or she needs to be emotionally lifted when depressed to allow productive output to continue. Can play a useful part in an over optimistic group by introducing realistic comments at a meeting. A stubborn depressive can be a problem in industry through continued caution and worrying. Praise is important to lift morale. Sympathy needs to be applied with discretion to avoid supporting a depressive tendency.

(e) Autistic Type This is a shy imaginative type who can contribute effectively to design and artistic skill. They need to be reminded of reality and have their ideas guided to finality. These people are most important to a company needing new ideas and innovation but can

be poor communicators and tend to retreat into their world rather than confront issues. Try to avoid embarrassing them while bringing them out of their timidity.

(f) Epileptoid Type This person is very detail conscious and an excellent project executive who follows through in detail to finish a task. They have difficulty in delegation and prefer to work on their own. They are idealistic in many ways and this perfectionism makes them excellent and thorough accountants. They do not like to be interrupted and need to be helped to take part in the wider plans of a company so that they do not become over involved in less important tasks.

(g) Normal Type A highly conforming and conventional type who have strong control over their emotions. Very useful in a crisis in which a calm logical approach is needed. Avoid over emotional action to keep the respect of this executive. Can tend to maintain seriousness and have difficulty relaxing.

All these characteristics can be obviously high or obviously low in a population of individuals with some not predominant. Recognition of these facets of an individual or the reverse of them can assist in motivating people and presenting ideas to them as well as supervising them. Elaborate sets of data based on this breakdown are available to assist in working with people with combinations of , for example, three predominant types from the above list and motivating them for their own sake and the benefit of the company. Many managers need a high component of paranoid (P), manic (M) and hysteroid (H) to push ideas forward and make a profit while able to enjoy contact with customers. However the combination of high P and high H may require some protection of company funds as part of the specification of the organisation in which that person is involved. Other combinations can also be effective in particular circumstances again with planning to augment any weaknesses that may exist and the provision of feed back activity as part of supervision as set out in chapter 2.6.

Examples of the use of this type of information in practice are:

* If a person's primary interest is money approach with financial benefits
* If prestige is the main motivation, point out the respect which will come from that person's peers.
* An extraverted person will respond when the opportunity for outside and new contacts are

available.

* A detail minded person will react favourably to a challenging project with only minor interference.

It is of course not correct to carry this powerful process to extremes which distort the overall message.

### 2.11.3 Welfare, Health and Safety

While health of the individual, their choice of diet and life style is theirs, there are considerations which a responsible employer can apply to promote the health and well being of employees. Both mental and physical welfare can be assisted for the benefit of the employee, the company and the society in which they both live. Some companies use their welfare department primarily for the purpose of wage and conditions monitoring together with provision of such services as that of entertainment in the canteen. Others take a more positive view such as regular audit of conditions including temperature, humidity and atmospheric control in the plant, electrical connections, the state of floors, exhaust systems at work stations, potential for RSI, machine guards and the practicality of loads to be lifted and negotiated. Added to these more obvious items are the more subtle questions of vetting all chemicals used in the plant for their effect on people, irresponsible behaviour within the plant and such items as mental stress due to pressure of responsibility and problems of compatibility both inside and outside the company.

Management needs to be aware of these needs on personal and economic grounds. The author has observed a division of opinion between a production supervisor and a technical manager in which a piece rate operator continually removed a fume protection extraction hood from a press to allow him to make more money when a severe health hazard applied and was obvious from routine medical testing. The technical manager took the view that the person should be removed from that task forthwith to the point of being forced to leave that firm unless he complied with the protection provided, while the production manager took the view that the wages were fair with the protection in place and the employee had been repeatedly warned

and in any case the company needed the skill demonstrated at that work station. Clearly the stupidity or foolhardiness of an employee should not be an excuse for not taking action in a case such as this and a top management policy on action to be taken on this type of situation is necessary including discipline for the supervisor who knowingly allows a health or safety risk of this type to continue. Allocation in the overall budget for expenditure to circumvent danger is therefore important not only for the reputation of the company as a safe place to work but to avoid substantial legal costs and claims in the event of an accident or health problem occurring, costs which can far outweigh the cost of correction in the first place. .

An area which is becoming increasingly important as an integral part of management is counselling. While this depends on the willingness to receive advice or even discuss one's problems with another person it is important to recognise when one of your employees is under stress whether this is due to problems at work or at home. Sometimes the effect on direct performance and adverse personal relations at work are so critical that there is no option but to raise the question with that person to try and resolve the problem or advise where outside help can be obtained.

One item which quite often arises in the personal affairs of staff members is that of money, overspending in response to trying to keep up with peers or over reacting to advertising pressures and hire purchase opportunities. This is a community problem. A prime example is borrowing on houses, appliances and vehicles such that monthly payments involving capital reduction and interest may be far too high in the event that a radical health breakdown or total family income drop occurs.

Some ability, or source of financial or legal assistance, may be required by every manager to cope with this need. In the current business climate the need for skill in these areas as well as an insight into compatibility and personality behaviour of the types indicated in 2.11.2 above is essential. This is a necessary part of any manager/engineer's skill if he/she is to manage an enterprise and contribute fully to its budgets and strategies.

# CHAPTER 3
# RECOMMENDATIONS TO CURRENT ENGINEERING PRACTICE

## 3.1 HISTORICAL BACKGROUND TO BUSINESS,TECHNOLOGY AND TECHNICAL EDUCATION

Before summarising the conclusions from the surveys of the management needs of engineers it is useful to consider some facets of Australia's industrial past and present. We can then see where we have come from in manufacturing, society and engineering education and appreciate that there have been radical changes. Management requirements are now much broader in terms of people, financial, contractural and overall responsibility terms and this requires, particularly for engineers, a greatly increased accent on decision making, personal communications and commercial skill to enable them to apply their valuable technical skills effectively.

### 3.1.1 Past Business Management and Technology in Australia

Some forty years ago in Australia, growth was the average business situation. Finance was based on rolling over working funds as the business expanded its sales and debtors. Filling the capital needs of machinery and operating facilities was by private shareholders, insurance company loans and agreements with suppliers as they would all benefit from expansion. Land and property prices were rising with inflation and a major part of investment was being channelled into property to make a quick income without having to produce anything. Investment in ancillary processes to supply sub-contracts was in terms of some form of contract but with a considerable degree of trust between the principals involved. Deals could be done between management and unions on prices and wages in relation to Canberra and tariffs.

In the forties, the author was employed in a two thousand employee public company as one of only three technology graduates in the whole company. Five students graduated in mechanical engineering at Melbourne university in the late forties, Swinburne and Melbourne alone now produce over fifteen times this number. Monash University was not in existence. The nature

of the training has changed. In technical education while the fundamentals of applied science have not changed, applications such as design of pipelines in hydraulics is now called fluid mechanics and emphasises such subjects as chaos theory with respect to vortex behaviour, the thermodynamics of steam engines and steam power stations tends to be replaced by the behaviour of gas turbines, pattern making and direct practice on a lathe has changed to study of the mathematics of metal cutting and control of numerical control machines. The philosophy of design and its comprehensive interaction throughout a business tends now to be subservient to CADCAM within production and often neglects the marketing implications and capital and operating cost calculations so essential to the design process . Many items previously matters of detailed stress calculation, in pressure vessels for example, now become skill in knowing where to look up a table of standards to cover that need. Metallurgy has now had plastics and composites added to become part of material science studies.

Production staff in our factories were hard working people drivers with skill in leadership of small groups. They were sceptical of trained technologists and overheads such as service people and regarded labour as part of a class structure involving mateship. Males were the predominant bread winners. Allied to this there was, and tends to still be, a tall poppy syndrome in which there was a tendency to try and bring those in authority or trying to better themselves "down to size", probably a heritage from the early days of colonisation. Australia was relatively immune from sudden capital movements into and out of the country, our stock exchanges being largely isolated from the rest of the world. Satellites were not operating on a global communication basis. Our economy largely depended on wool, wheat and our exports of minerals such as iron ore, bauxite, copper, lead, zinc, nickel and gold. Melbourne was the financial hub of the country, largely through the financial strength of the mining companies. Broken Hill output had many years to run. Mt Isa, Kalgoorlie, Broken Hill and Newcastle flourished. We strived to buy our quarter acre blocks and borrowed on a very reasonable fixed interest basis to build our houses. Many of us built or renovated our own homes and put up with limited facilities as part of our initial family years. Transport was not a major problem compared to the present situation. Tenement houses around the city centres were cheap. Suburban expansion had reached to around 20 km from the centre, in the case of Melbourne,

with building blocks at the equivalent of only around $ 2000-$3000 thirty km. from the city centre.

In the earlier days of our country there was a strong degree of mateship in which helping the underdog, stopping to pick up people along a country road and giving a person some task to keep them alive was the norm. We have moved from this situation due to a number of social and political pressures to what appears to be a more selfish and material relationship between people and this needs recognition by engineers or they will be relegated by other professions to a role less than that which the community needs from them. Engineers clearly need to strengthen their communication and marketing skills to prevent further deterioration in this respect.

Tariffs and bounties were protective of many industries, textiles and printing for example, primarily to allow a wage structure in those industries in line with a general standard of living based on agricultural and mining income. Loans with fixed interest were available on a long term basis of around 7% from insurance companies. The accent in industrial engineering was on labour intensive operations where many people carrying out the same task were subject to detailed methods study allied to layout and flow analysis within plants. This accent on labour costs was accentuated in later years by wage rises of as much as 20% over a few years in some industries. Jobs were generally available for those who wanted them. Apprenticeship opportunities were readily taken up. We made a substantial portion of our own production equipment, machine tools, nuts, bolts and farming equipment. The Federal government of all persuasions had the courage to invest in the Snowy River Scheme with depreciation on a 70 year basis and later backed university and science education and their libraries for long term community benefit. The professions were regarded as contributors to society not as a way to obtain a high starting salary, as their education was largely paid for by the community.

The management of many of our businesses was by entrepreneurial individuals, production minded individuals, brokers and financiers without a lot of professional experience. These people demonstrated drive and hard work but except in the mining and farm machinery industries had only limited knowledge of the contribution that could come from engineering

skill and logic. They mistrusted academic people in general and were naïve about predators with more informed financial minds and often left themselves open to an overseas purchaser who bought their hard won, but cash strapped businesses some time after they had been established. At this time some senior academic engineers, lawyers, medical and agricultural scientists played an important part in community policy by speaking out on community matters.

Budgeting was a major clerical operation requiring several weeks to perform, even in a medium size business, and often delegated to an outside accountant who had no responsibility for implementation and only limited knowledge of the long term strategies and technical implications of the budgeting process. Office accounts were often on cards and accounts were taken up to a trial balance stage before being taken over by the accountant. Cost accounting was based on arithmetic variances and standards often based on those of a skilled rather than an average operator, as determined by time study personnel. The questions of automation, overseas market potential and the effect of exaggerated sales and hence excess stocks and the effect of impulsive purchases of capital requirements often only surfaced at the time of crisis they caused. Export trade was substantial with England as there was no European common market. U.K. had a tradition of turning our raw materials into value added goods, buying our agricultural products and investing in our industries. We imported a large number of English cars. Most executives had secretaries using typewriters often for work now done directly by executives using a word processing computer. Twenty five years ago a computer and printer which cost the equivalent to one million dollars of current value was required to do the same work as a current PC costing only a few thousand dollars yet the modern unit is much faster and more reliable.

Immigration played a most important part in management decision making in these intervening years. Migrants from England and southern Europe played a significant part in contributing new vitality and stability within our labour resources particularly in construction and manufacture. These migrants were hard working and determined to save, they wanted their children to have the benefits of education and despite teething troubles initially, they have made, and continue to make, a substantial contribution to our industries and culture.

More recently migrants from South East Asia have played their part , in commercial, computer, medical and catering fields for example. These new citizens have helped to stabilise labour costs and facilitate cultural development and trade opportunities of increasing importance to Australia. Some of the migrants have brought cultures which are more material and commercial than many of the Australians they joined, particularly in their "shop keeping" approach to business, that is, their ability to buy and sell, so necessary when dealing on a global basis. We need to realise that the British, and in fact most European and Asian business people, working from their respective countries have been adept at this facet of business for centuries. Hopefully we can all, including our engineers, be more astute in this area of our management in future.

### 3.1.2 Current Management and Technology Climate

The current business climate in Australia is one of dynamic global impact and a reduction of isolation, not only as a nation but as individuals and companies and in our professions. To operate at the speed and skill required to maintain the average standard of living of Australia, dictates that a high level of education at all parts of society is needed. This need is both cultural and commercial/industrial since communication is a vital ingredient not only for effective management of our enterprises but as a requirement of staff throughout a company. It is the management of a combination of inputs, outputs and responses to our technology, customers, staff and suppliers which is now the most important ingredient affecting our industrial and community service future. At the same time we have to face the widening division the country faces between those who can cope with this revolution in communications, and can use the new electronic facilities and global equity movement skills efficiently, and those who cannot participate in this way due to psychological, cultural, educational or intelligence barriers. This has also led to a disparity of incomes and we know that extremes in any country can lead to class jealousies and frustration for the needy. The rate of change in technology, year by year, due to the use of computer chips, satellites and application software packages places stress on an individual's and a company's ability to cope. This is now combined with the impact of changes in an executive's family structure due to mobility of jobs, adversarial media impact associated with the dynamics of the media itself,

and a feeling of weakness as far as job security is concerned. The increase in short term contract work, takeovers and reduction in supplier and customer loyalties are now such that the engineer/manager is in need of specialist business knowledge, in addition to applied science, in the current era if he/she is to be able to deal with fellow staff , the market forces , suppliers and financiers at all levels. The financial impact is now so important in technical decisions. An example is the current rate of depreciation of say 33% on electronic equipment caused by obsolescence. This is quite different from just providing long term maintenance to overcome the wearing out of machinery. This rate of rate of capital loss is a direct cost. It not only tends to be underestimated by those directly involved but also causes stress due to the retraining needs involved. Even the software is largely a "right to use" item often repeatedly made obsolete by new versions involving new training without necessarily giving a compensating advantage.

It is part of our culture and the need of our current democratic society that people have a say. We may debate whether democracy is the quickest response in a crisis, but in the normal course of a healthy and progressive business, democracy in the form of participation is vital for full utilisation of the skills of people in a business and the provision of stability and continuous employment . The ideas of people at the coal face are invaluable in improving and innovating within a company and this quality should therefore be cultivated at all times and at all levels. Managers are primarily developers of people and as far as practical should have an open door policy to encourage comment. This policy requires patience and a willingness to delegate as well as a need to sublimate one's ego and recognise that technology and knowledge of process although important needs to be combined with people, financial and marketing skills in an engineer/manager's make up.

Sub-contracting at one end of a business and design to a customer's requirement at the other, need to be combined with economic in-plant production methods. These are the current imperatives for business management and therefore the engineer. This leads to a need for an effective management information system throughout a whole organisation as well as strong liaison and a continued contribution from its executives. Both ends of a business need engineering skill. Discussions with customers about design changes which lead to lower

production costs with fewer components in a product and provide greater reception from the ultimate consumer all need to take place regularly. Suppliers need to be encouraged to improve processes so that the sub-contracted products are easily assembled and meet specification. Investment into a sub-contractor may be a better scheme than in one's own plant provided a degree of long term loyalty is part of the contract. Trust needs to be developed and maintained with the supplier to avoid the implication that the principal is not just a cost cutter and ensures that the supplier does not adjust prices without prior consultation. Both the long term and short term financial plans for each part of the organisation need to be discussed and modified in conjunction with the finance manager so that discussions at budget time are well understood and investment timing is coordinated. The survey of departmental needs for engineers set out in chapter 2 shows clearly that we can no longer afford to regard the particular department in which we are engaged as the only interest to be protected if we want the whole enterprise to survive and prosper.

Current governments have a policy of retiring debt by selling off state owned assets ranging from educational property to electricity and gas suppliers together with their distribution facilities. The principle of "user pays" as distinct from provision of a necessary community service is part of this philosophy and this has tended to give rise to more private contracts instead of government employment particularly in major civil engineering contract work. This has led to a rearrangement of the terms of employment of many professional engineers, often leading to less tenure of employment and a need for engineers to have a knowledge of how to run a businesses and organise their own affairs on a self employed long term business basis if necessary. Using this asset sales technique governments no longer have to guarantee very large purchases for industry from overseas suppliers such as aircraft manufacturers and in a similar manner employers no longer have to provide for direct retirement planning, sick pay etc in long term for employees. They consider they cover these issues by loading each contract with allowances for future needs. This trend is unlikely to diminish because of its substantial financial gain to governments.

The average business person in the current economic climate in Australia is subject to a mass of media over sell. Such matters as the wonders of the internet, mobile phones, computer

hardware and software, share and property purchases, currency and interest rates, and even the emphasis on tragedies and crises, are so predominant that there is a bias away from production which still has to take place to make products and motivate people and get those products into customer's hands. The engineer therefore has to be more of a generalist and be more flexible in outlook, not only to be able to understand these pressures, but to have the discernment to channel them towards exercise of their business and technical skills and be able to contribute to society as well as earn a living. Advanced degrees for technical people without an overall view involving customers, suppliers and people development can lead to frustration in both their personal and professional lives. These highly trained engineers need the business skills detailed in this thesis to be able to fully contribute to our industries and technical education.

Price is now the major item affecting sales in the current business climate. Success is often assessed in the community in monetary terms. Labour turnover is relatively high in the marketing and sales areas and this tends to weaken long term relationships with customers. Staff training to meet the needs of new technologies is now a major cost, in fact some trade skills such as preparation for printing are now quite different from that of only a few years ago. Saving is not paramount in many families and many people continuously live up to their income even borrowing for average living as well as for investment in their houses, cars and holidays. This is unfortunately reflected in their approach to business so that engineers need to be aware of this when necessary risks are taken and encourage a degree of saving and common sense conservation amongst their colleagues and those who work in the firm. This will in turn encourage long term strategies to be appreciated and then incorporated into budget planning.

If we examine the 20 largest shareholders of the majority of public companies they consist largely of institutional investors, insurance, superannuation and trust funds. Past performance shows that these organisations are currently primarily run by accountants and lawyers, often professional directors, and often see their job as preserving shareholder equity and obtaining capital gain rather than encouraging long term investment and R&D in the companies they control. This means that share values on the stock exchange and dividend policies involving

price/earnings ratios are of major importance to them. As the federal government has dictated that all companies send funds to insurance groups for the benefit of retirees an enormous flow of savings now goes to these insurance and investment groups and gives them substantial economic power over our public companies. The irony of this situation, which is not yet fully recognised, is that many of these public companies including the largest ones have now placed more than half their capital in overseas countries employing overseas citizens. These companies have now become Australian multinationals making concrete pipes in U.S.A., rubber and automotive products in S.E.Asia and have established banks and insurance interests in U.K. .At the same time integrated investments with Japan play a major part in the stability of our export of such minerals as iron ore and gas from Western Australia. Engineers need to be equipped to take their part in the top management and boards of these Australian multinationals which are backed by local savings to see that short term and long term developments receive proper attention both locally and overseas. They should have a say for the sake of the survival and prosperity of these businesses in both the technological and commercial aspects their short and long term budgets. At the same time the government will need to legislate that in future a reasonable portion of compulsory national savings are invested back into Australia if Australian engineers are to have the opportunity of developing our own industries with our own people.

## 3.2 Review of an Engineers needs in the Principal Departments

Examination of the responsibilities of the board (chapter 2.1) and the responsibilities of the direct control department executives (chapters 2.2 to 2.6) relative to traditional engineering and technology practice in the context of Australian industry is the subject of this section of the thesis. It is considered that the following activities and methods of operating need attention for many engineers if they are to play a full part in the senior management of our enterprises and fully contribute to their improvement. The majority of manufacturing and commercial firms, particularly those with a technology base, need more engineers on their boards and as general managers if they are to become world competitive, quite apart from the vital part they can play in political and community leadership. The opportunities are there in top management provided engineers have, or proceed to acquire, knowledge of the two areas

of additional skills they need as summarised in terms of technology and business in 3.2.1 and 3.2.2 below. More detailed comments on the engineer's needs as far as the service departments are concerned are set out in section 3.3. Finally a brief summary is provided in section 3.4 of the overall needs of engineers as managers and how these can be assisted using the focus of comprehensive planning software to give cohesion.

### 3.2.1 Technology and allied Skills

- Be aware that while the principles guiding technology applications are unchanged the applications of technology are continually changing on a global basis and therefore engineers need to keep up to date with the changes in their industry internationally and be able to apply business skills to manage these changes effectively.
- Understand how to ensure that the overall company budgeting procedures and the implementation of budget decisions are efficient using a combination of software and personal communication skills. In addition to an appreciation of the detailed requirements of modern production planning systems there is a need to ensure that financial, marketing and subcontracting budget policy inputs are incorporated into a production planning system to make it efficient.
- Be able to run meetings, provide leadership and take overall responsibility for activities of a diverse group who do not necessarily think, or are motivated by, applied science and engineering logic. Recognise the importance of skills other than those of engineers and technologists and respect the contribution that can be made by legal, commercial and trades people as well as intelligent experienced people without academic training or fluency in English.
- Know how to manage the specialist functions, outlined in chapter 2.6 and detailed in chapters 2.7 to 2.11, which can contribute to management. Know where to obtain their skills and how to guide these functions for the benefit of an organisation. Ensure that customer and supplier liaison receives consideration by the production department as far as design, cost control and investment activities are concerned.
- Be able to apply such items as Newton's laws of motion, the nature of inertia and the combined application of forces as well as the statistical basis for probability and risk

taking, to people and financial situations involving staff, customers, suppliers and allied market projections.

- Be able to critically appraise the advantages, disadvantages and timing of capital expenditure proposals in both accounting and strategic terms in addition to the technical merits of a potential purchase.

### 3.2.2 Business and Communication Skills

- Break down the division between lines of authority and responsibility as far as working together is concerned. Include in this team work, respect between departments, customers, suppliers, financiers, shareholders and the community in which the organisation operates. A corollary to this is the need to encourage mutual respect between direct production people and those in the service departments and "overheads" which are an integral part of a business.
- Appreciate supply and demand questions as they apply to pricing, market share, purchasing and special skills. Relate this approach to legal and financial aspects of borrowing, investment in people, products, markets and property as well as purchase of machines and systems.
- Development, entrepreneurial, risk taking and innovation skills as part of decision making.
- Learn of the macro economic environment in which one's industry and nation is operating. Broadening of personal interests can be of advantage in this respect quite apart from technical contacts and engineering associations.
- Be able to understand basic accounting and stock market operation, as well as the nature and responsibilities of a corporation, shareholders and directors.
- Be flexible in the use of organisation structure as a dynamic management tool to define areas of direct responsibility for company activities, recognising the varying attributes of people, required span of control and the importance of area management.
- Know when to be firm about your views and when a compromise or a delay in implementation involving further liaison is justified.

### 3.3 Review of an Engineers Service Department Needs.

As far as the service departments are concerned the first point to recognise is their importance in particular businesses and how they operate to support the direct operating departments as explained in chapter 2.6. The Planning, Budgeting and Control functions described in chapters 2.7 and 2.8 and the Staff Development activities of chapter 2.11 need detailed attention in some form in every business. The principles involved in chapter 2.8 MIS, Control and Information Technology, 2.9 Process Control and R&D and 2.10 Design are usually well understood by engineers but the need for their comprehensive application for the whole firm, not just in production, is not always recognised.

Whether these services are included as a separate department, vested in the wisdom of a few individuals, or contracted out as required, the engineer manager needs to be able to know enough about the function of each skill to be able to access these skills as the need arises. Many of the planning , management information systems and allied information technology and quality improvement procedures require continual review as the company's products, processes and personnel change. Audit of a company's service needs and regular maintenance of data entered and the software in use is therefore an essential part of service department management.

Emphasis at both board and general management levels on financing the relevant service departments is critical. Not only encouragement but correct investment can save costs in long term. In maintenance, as just one example, participation and comment prior to a budgeted capital allocation, even if the proposed initial cost is increased, can save substantial repair and depreciation costs later as a longer life is achieved and less repairs result. Investment in trials of components, processes and pilot stage development, prior to a major capital purchase makes for a wiser and less costly purchase and allows an investment ahead of one's competitors.

An active part by the service's coordinator , described in chapter 2.6, in the company's budget process is as important as the input from the direct operating departments. Rather than being

regarded as just another cost they should be considered as positive contributors to profit, and a vital part of communications and planning for the future. These departments should not be placed too far away from the production and marketing departments to facilitate discussions and meetings both formal and informal between the staff of each department. The systems and the I.T. part of chapter 2.8, and the design and robotics of chapter 2.10 need to be set up to meet actual needs and this implies close liaison throughout the organisation. This need is becoming more critical as a proliferation of programmer contracts and new software enters the service departments. Close control of programming by frequent meetings as it is developed to keep it in line with realistic design aims and the firm's objectives, not the programmer's perception of those objectives is now an important supervisory need.

## 3.4 An Engineer's Management Needs and the Application of Comprehensive Budget Planning

From the above comments it can be seen that many engineers, by attention to increasing their knowledge outside technologies and by improving their personnel skills, can play an important and necessary part in the overall management, budgeting and master planning of an organisation. It can also be observed that global market and communication advances and the rate of change in technology make it imperative for Australian industry that engineers, the people who can appreciate how to develop and use these changes to advantage, take more management responsibility. To achieve this they need to broaden their approach to people and business management by taking a more positive view of the potential of their profession and so achieve a major responsibility within company management. If engineers do not take this initiative and share more of this responsibility with commerce and legal professionals we will fall behind our international competitors and be less able to maintain our standard of living and level of employment.

The simulation procedures developed by the author as a result of management research and business experience is explained in chapter 4. It has proved effective in master planning aimed at overcoming many of the needs outlined above. This approach to budgeting involves:

- All major facets of business activities
- The education of engineers and senior management in the comprehensive running of a company. This is achieved by combining business and technology decision making in the budgeting process. The comprehensive software reduces the resistance often caused by the need for expensive and time consuming revision when the view points of many participants is involved.
- Improvement of personal communications and participation in planning by staff. The result is staff take responsibility for implementation of forward plans they have personally helped to develop.
- The board of a company, by insisting on proper participative and integrated budgeting procedures to which they also contribute, approve and monitor, can see that their shareholder's interests including profits and assets are protected and the management of the company is developed.
- Engineers, who have learnt from this process and participated in it, are then placed on the short list for appointment to board and general management positions when appointments to these positions are made.

# CHAPTER 4
# BUDGET SUPPORT SYSTEM

**A system for overall company planning developed to assist the management of an enterprise, and results of case studies involving application of the simulation developed.**

## 4.1 BACKGROUND – THE STIMULUS AND THE DEVELOPMENT

### 4.1.1 The Stimulus

From an engineering and operations management position in a rapidly expanding private company the author was, as a director of the company, asked to take on the administration and financial management of the company. The company further expanded its market and facilities and financed this by floating to a public company on the stock exchange. The need for financial control, particularly as to production, purchasing and responsibility for investments by suppliers in their facilities, before and after the float, was a major concern.

Over estimation of sales even in a buoyant market could have been disastrous since any excess production of the perishable stocks involved, unlike castings for example, would incur substantial initial and escalating refrigeration and holding costs quite apart from loss of the already limited working capital. On the other hand underestimation of sales would have reduced the firm's leadership in the market place and allowed competitors to gain market share and weaken the company's future security. These considerations were further accentuated by trust relations with major suppliers who depended on this firm for around twenty times this company's capital had been invested by others, to establish the supplier's processes or supply generous terms of trade, largely because of faith in our management of both our own and their business sales.

Preparation of the forward planning budgets and their revision to test the effect of alternative strategies could take up to three weeks of clerical / accounting time during this critical expansion phase of the firm's development. This was a costly and time consuming task but not that critical to decision making until an extension of the board took place as part of the

floating of the company. By this process its share price on the stock market became subject to any premature biased comment on forward plans to the media prior to careful budget calculation. At this point the author resolved to try and develop rapid methods of demonstrating the effect of business proposals, to check the effect of alternative policies by a board the same day, and immediately arrive at practical forward planning decisions. The aim at that time was to prevent a premature decision being publicised or implemented by limited vision executive entrepreneurs on the board, sometimes with a personal agenda unrelated to that of the firm.

As with many research projects the development of rapid budgeting procedures since this important original stimulus has opened up a much wider range of benefits for management. The budget support system now has the advantage of combining technological advances with the immediate business needs of small and medium size enterprises in a rapidly changing economic and social structure. It improves the vitality, viability and profitability of businesses by promoting participation as well as sound planning.

### 4.1.2 Summary of the Development of Budget Support Programs

The development and application of a budget management program was initiated thirty five years ago with the development of a hydraulic simulation demonstration model of a manufacturing firm's cash flow. This model, figure 32, was set up by the author in the hydraulic laboratory of what is now the Caulfield Campus of Monash University [49][50]as an open day visual demonstration. It showed how a firm's sales income, represented by water pumped through the system, was distributed throughout a firm. It demonstrated break even point and provided a visual liquid measure of profitability depending on the setting of a ratio control valve which altered the ratio of raw materials "liquid" costs to sales income. Measurement of overheads, labour, and raw material costs as well as profits was by using V notches in the output flow channels. As a demonstration it proved very effective as income changed. One observation was the importance of the capacity of the tank representing the bank during a transient change in sales and similarly the capacity of intermediate channels carrying flow to materials, labour and overhead outlets during the time income was adjusted.

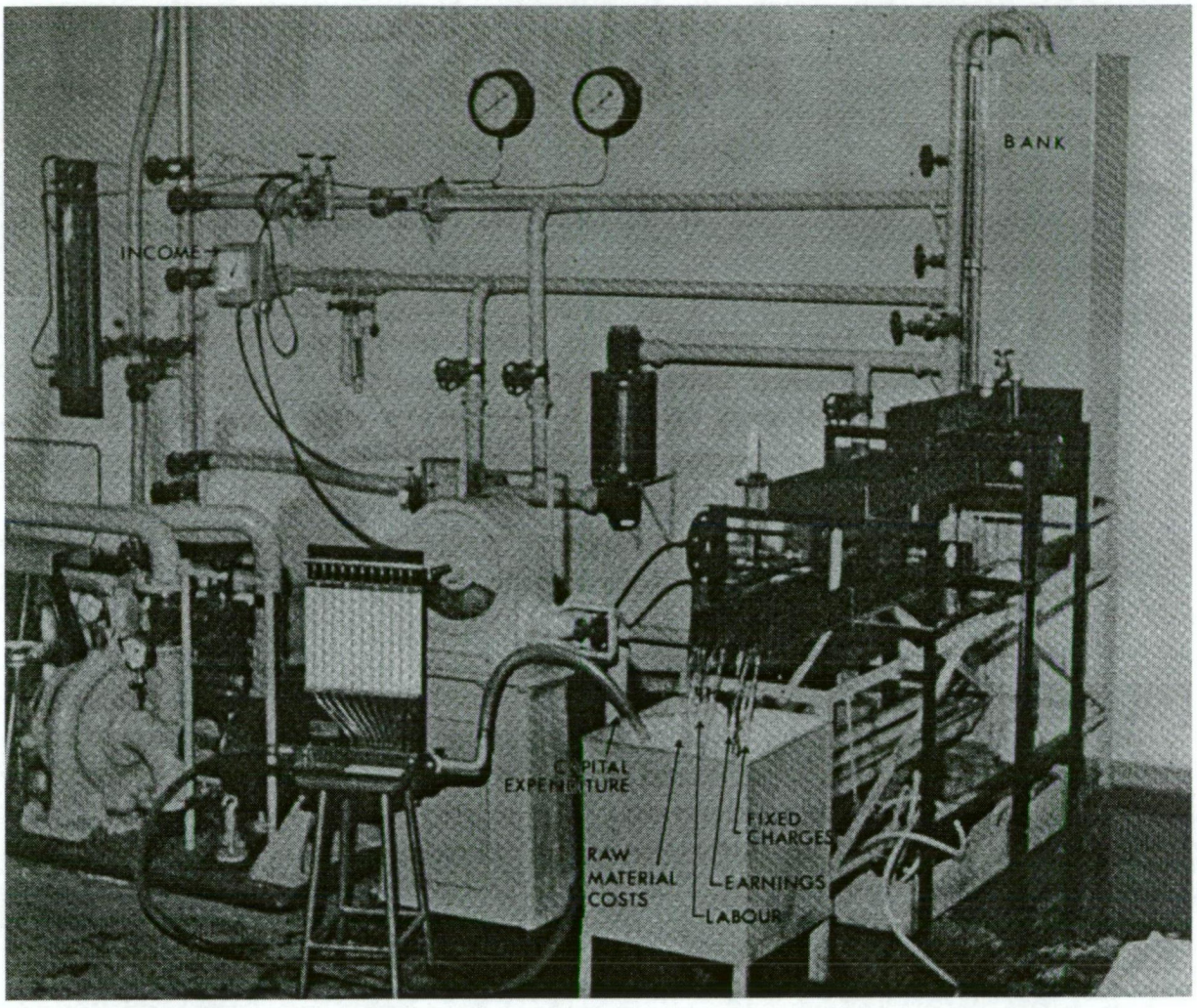



**Figure 32 A hydraulic model which demonstrated the cash flow within a manufacturing business and showed the effect of different ratios of external purchases to sales on profit and break even point.**

Following the development of the hydraulic model it was decided to pursue a mathematical simulation of a business and develop budget calculation procedures applicable to budget preparation using the enormous potential of large computer services which although very capital intensive at that time were available for contract work at the University of Melbourne. Following preliminary studies setting out mathematical equations for some of the principal relationships between the accounting criteria required to define forward company plans it was found that parallel with this research more advanced software had been developed by Associate Professor Richard Mattessich, of the University of California, Berkeley and set out

in his 1964 book [46], "Accounting and Analytical Methods". Its subtitle "Measurement and Projection of Income and Wealth in the Micro- and Macro- Economy" was also directly relevant to our research. It has been from these earlier insights using more recently developed commercial computer software and hardware and modification of the original programs to reflect current terminology and local accounting practice that the Budget Support system has been developed. Ancillary programs to assist pricing and planning using the standards calculated from the simulation have been added to augment the business needs of small to medium size businesses.

In his book Mattessich [46] pages 402-405, sets out the relationships leading to the basic equations applicable to accounting calculation of a whole organisation. These are included in abbreviated form as appendix C together with a glossary of the symbols used in the final Budget Support software and also listed in the F8 Help section of the program [47], appendix D included in the back cover of this thesis. A description of each of the 90 data criteria and matrices used by the software is included in appendix C and also in item F5 of the Help program [47].

The resulting Budget Support program described in its manual [47] includes not only a copy of its draw down menu, figure 33 from reference 47, and instructions for its screen presentation but also chapter 7 of the manual covers its use for control and continuous improvement. The index includes both page references and a list of the many functions of management referred to in the manual to assist in its management improvement applications.

The model provides a systematic and executive involving way of preparing budgets, cost standards, department work loads and management reports as components of a management information system. One of the aims of this work has been to bring out the basics of financial management for practicing engineers and managers so that they become aware of the total implications of their decisions. It has assisted in the training of young engineers in the principles involved in business management so that they can move to senior positions in our industries soon after graduation and consequently be skilled in the combination of technical and business skills so necessary now and in the immediate future.

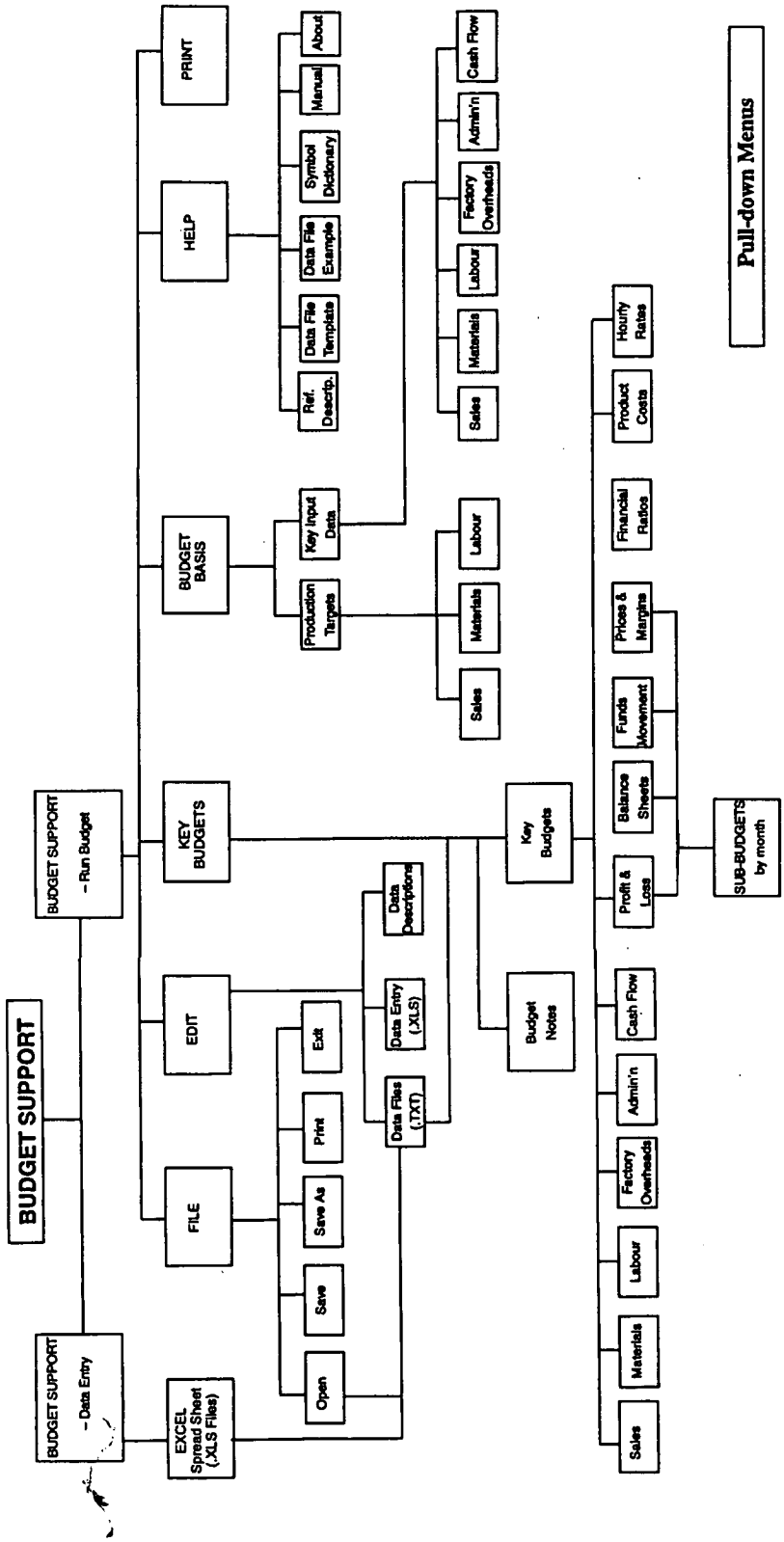



**Figure 33 Budget Support Pull Down Menu**

Further development of the simulation software followed and its repeated checking in actual practice in an enterprise has been carried out under the author's supervision with the assistance of programming sub-contracts and as part of financial management training for special project research students in the Mechanical and Manufacturing Engineering department of the University of Melbourne. This has moved the development process from its program development to the "black box" stage with more recently a concentration on its presentation and application to provide standards for pricing and planning. Current emphasis is on its application to the development of a management team in particular its use by engineers as managers and its encouragement of participation throughout an organisation to give optimum profitability and security in a highly competitive local and global economy.

Engineers, by studying the model's construction and collecting the data required to run it build an understanding of each of the significant items affecting the management of a company, its facilities, staff, finances and markets. Management improvement was a feature at the time of the simulation's initial introduction and its regular budget review meetings.

As Richard Mattessich wrote back in 1964, "the translation of accounting into mathematical terms ... has a great practical potential" " The application of matrix algebra to the economic sciences, the advent of electronic processing, and the creation of mnemonic (memory aiding) source languages have provided the preconditions which were lacking until recently". When we consider the staggering improvement in the speed and economy of these processing tools since 1964 it is not surprising that Mattessich's prediction has now come about.

As a further prediction he suggested that an accounting system whose entries are not numerals, but behavioural functions and identities, may be employed beyond budgeting in the narrow sense of the word. As risk taking and a consolidation of viewpoints and trends is a vital part of budget prediction he was in some ways pointing to the need for much wider people participation to produce wiser budgets and the importance of the motivation required to implement a budget.

Modern "fuzzy logic" mathematicians of year 2000 and beyond will no doubt develop this idea of introducing perceptions and probabilities into the budget preparation process in future.

## 4.2 INTRODUCTION, MAINTENANCE AND OPERATION OF BUDGET SUPPORT

The first step in introducing the Budget support concept to convince its management, its board and its general manager is to establish that there is a need for a more comprehensive and technically advanced approach to coordinating their company. There will be some form of planning in place now and parts of that existing structure can be incorporated into the new system.

There will be symptoms indicating the need for a new or revised approach. Some of these pointers are the need for lower staff turnover and lack of follow through on top management decisions. Insufficient forward planning and some middle management costs too high or ineffective are also signs of need. Often this is due to too many layers between board and the final person responsible for action. There is the potential executive such as the engineer only needing business experience to enable him/her to develop. By being requested to participate in wide ranging planning meetings, with a coordinating software structure involving both technology and business, most engineers will absorb the required business skills and be prepared for further responsibility.

Another sign of weakness which can be helped by participatory budget planning is where staff are unable to harness the technical advantages inherent in the firm's capital and staff investment. In this category are accountants, engineers or marketing departments with a prevailing defensive approach to the function of their particular department combined with a feeling of insecurity rather than a pride in applying their knowledge to overall development. In these circumstances the bottom line suffers. Perhaps the most profound case for review is where the staff are living within their past , in the false belief that their professional identity, their socio-economic group will protect them from competition.

An area where the engineer can contribute at planning meetings is when there is a fear of technology within the allied departments of the firm. In the author's experience over many years of contact with companies needing rehabilitation the primary weaknesses are at the top.

In the board room and in senior management there is often very little engineering or technology expertise at those levels and only limited ideas of how the parts of the business should work together. In these cases there is often a lack of a formalised system which pulls ideas together, stimulates innovation and steers the finances of the company as it copes with competition from local and overseas competitors.

The section 4.2.1 below describes the initial steps required to introduce a budget planning procedure to overcome many of these management problems. The first need is to get the communication data right by seeing that the periods of the budget, the names of the components, departments and sub-total descriptions are agreed throughout the plant. This work already contributes to the cohesion within the company. Defining the data then follows and initial budgets are then agreed after consolidation of ideas between marketing, production, finance and service executives with the guidance of the general manager.

The next section 4.2.2 describes maintenance and consolidation following development of the initial simulation. Meetings to discuss variations of actual results from the budget plans take place on a regular basis using the coordinating focus of the budgeting process to quickly check the potential of any proposed changes. Finally rules for ensuring the continuity of action are presented and in particular, the role of the budget coordinator, the general manager and responsibility for any software and hardware updating required.

### 4.2.1 Setting up the Program and obtaining the Data applicable to an Organisation

#### 4.2.1.1 Names and units of products or sub-assemblies, raw materials, departments and account categories to be entered as data

An important initial procedure is to coordinate the views of the potential users of Budget Support as to the titles to be adopted to define the sub-assemblies/products being produced.[47] By identifying the sub-assemblies, that is the components that are inherent in a wide range of products, the number of sales items is substantially reduced. This simplifies management decision making as well as computer requirements to operate the system and results in component standards which are readily applicable to pricing and production

planning. This applies even if for example, to reduce the number of components, the dollar value, weight or area are used as a unit of component. The standard units by which each is measured needs to be set down in the data for reference later. In the same way each of the material and sub-contract groups need to be named and their units described. Selection of these units should take into account the common descriptions of the industry and the firm, as used in its purchasing for example. The titles and scope of each of the sales, production and service departments of the organisation need to be in line with the structure of the firm. This information is required to facilitate communication and encourage responsibility when working towards agreement and later implementation of the budget.

The categories of the factory overheads and the administration overheads are generally in line with the accounting of companies. They should be defined to assist in estimating their costs and in allocating responsibility. In both these cases costs are broken down into fixed and variable expenses and then distributed to determine unit costs. The initial item in the variable expense category in factory overheads and administration costs is a wage cost. In factory overheads this item primarily supervision is based on total departmental direct wages and in administration overheads primarily sales salaries, based on total sales.

The descriptions of the standard account items used in the profit and loss, balance sheets, funds movements and financial reports are along traditional accounting lines. It is best to align the company books and the model's data descriptions with the same heading for the same item. Sometimes Budget Support gives rise to the need for a change in the grouping of data collection in the company's books. This enables the company to meet future management requirements and allow comparison between the budgets and actual performance.

It has been found that too many categories lead to weaker management since it can cause a reduction in emphasis on the items which matter. Some grouping is therefore required to reduce the amount of detail reported. As already emphasised the use of the sub-assemblies which make up a wide range of products is recommended to reduce the number of "products". In addition this procedure allows a costing, and hence pricing, system to be based on sub-

assembly costs calculated directly from the budget. Production planning can also be assisted using sub-assembly results.

Summing up this simulation of a productive organisation, particularly a manufacturing company, can contribute substantially to the training and later practice of engineers as managers. It involves the interaction of computer, accounting, facilities, technology and management skills and the need for action to continually promote improvement at all levels of a firm. The interaction between a range of disciplines such as legal and commercial professionals necessary to define the budget data and weld a group together widens the horizons of engineers and prepares them for the management contribution our businesses need from them.

#### 4.2.1.2 Method of data entry

**General** The Budget Support program [47] does the calculations to produce the budgets based on a data file of around 1000 items within a series of numerical matrices. To produce this data file, data entry first takes place using an Excel spread sheet program, see the left hand side of the pull down menu figure 33, designed to include a reference number and brief description to make data entry easy and highlight the data of each matrix. Precise entry positions are allocated for each item to facilitate entry. When all entries are in place to the satisfaction of the person entering the data the program checks that there is an entry for all points and the file is then saved as a data file using a macro. The program then allows the operator to transfer the Excel data file suitable for application by the main Budget Support program so that program can product any required budgets and standards.

It is interesting that for a particular budget period and a specific organisation certain items are found to be critical to performance. These items can be the subject of separate tests to check alternative budget strategies by referring directly to their reference numbers and altering those items to check the effect of perceived extremes of value. This is particularly useful in terms of budget maintenance and continuity when the budgeting procedure has already been established so that following a planning conference there is no need to reenter all the data to run a new budget.

Collecting the data requires tact and cooperation particularly with the accounting people and in the development of participation by the key executives if some parts of the budgeting process and responsibility is new to them. The sub-totals of the first budgets from any inaugural data file need to be checked against past figures from the books of the company for common sense. Wrong decimal points and anomalies need to be picked up before presentation and acceptance as a valid model of the company's operations.

Since the whole of a company's affairs are interrelated in the program one has only to change a few initial component production multipliers of past performance and some fixed cost parameters to allow a rerun of the whole budget. This is very useful when carrying out "what if " budget assessments. An opening windows option next to "Budget Support" allows selection of **Data Entry**, **Run Budget** or **Budget Comparison**. Budget Comparison allows actual real time data to be entered and compared with the previously agreed budget figures. An operating menu system for the Budget Support computer screen in line with the pull down menu of figure 33 has been designed to highlight the key items of the budget and allow staff to readily access a path into the programs. It places accent on management rather than computer operating skills.

**Balance sheet, trading, production and overhead data.** The entry information to the program for a new budget period builds on the immediate past balance sheet of the company and its existing obligations and stocks. The opening periods of the cash budget needs information extracted from the past books of the company of transactions which took place prior to the new budget period. Terms of trade are obtained by analysing performance in the debtor's and creditor's ledgers of the company. These terms of trade cover when to expect sales income and when creditor payments need to be made, in terms of 30, 60 or 90 days for example. Expected income and expenditure details for such items as loans, shares, leases and hire purchase transactions, plant purchases and disposals are all defined in terms of amount and when each is expected to take place.

Before entering operating data into the program it is necessary to examine a previous year's production and sales of the sub-assemblies. It is then necessary to determine multipliers of these figures in line with forecasts of sales for each sub-assembly during the coming period. The prices expected throughout the coming period for each sub-assembly should also be estimated at this time. Production requirements are adjusted by the program in line with forecast sales and stocks held. To achieve this the data includes both initial stocks and the minimum stocks of raw materials and finished stock to be held during the period of the budget. The desired units of finished product stock are also included in the data. How production is to be spread over the budget period is also defined in the data. The net result of applying this data to the program is the ability to produce a production budget in terms of units required to meet the sales targets.

The material purchasing requirements are arrived at by the program from data defining when it will be most advantageous to purchase the required raw materials. The fraction of raw materials and sub-contracts required to make each sub-assembly and its cost per unit are a next step in the data entry. The net result of these data entries is to allow calculation of a raw materials and sub-contract purchasing budget.

The labour usage applicable to the direct labour departments covering sales, production together with a service allocation back into these departments is now entered as a matrix of hours for the whole span of the budget. Labour is spread by the program throughout the budget period in proportion to calculated production for each part of the budget. In addition data is entered setting out the actual labour pay rates per hour for each department. Note that service department hours are either added into the variable wage estimates, or added into the production and sales departments to which they contribute. This applies to such activities as production planning, IT, quality control, maintenance and industrial engineering.

Overheads are treated in two categories: first those directly associated with factory activity, "Factory Overheads", and second those associated with marketing, overall management and office administration, "Administration". As already explained the components of these overheads are calculated on the following basis. Supervision costs in the factory overheads

are calculated using data defining the cost of supervision as a fraction of the total dollars of direct labour. Salaries/sales wages in the administration category are calculated as a fraction of the total estimated sales dollars. A division is made between fixed and variable components within both these overhead cost categories. The program allows depreciation to be a cost as far as profit and loss is concerned but recognises that depreciation makes a contribution to cash when it calculates the cash budget. For both these overheads, reference to immediate past accounting figures showing sales and wages is helpful in determining the variable overheads data.

### 4.2.1.3 Using the program for data entry

Referring to the menu on the Budget Support screen figure 34 if it is desired to locate a file from the DATA ENTRY.XLS list one can proceed directly to amend the spreadsheet (.TXT files refer to the main program data files, .XLS files refer to the Excel spreadsheet files).

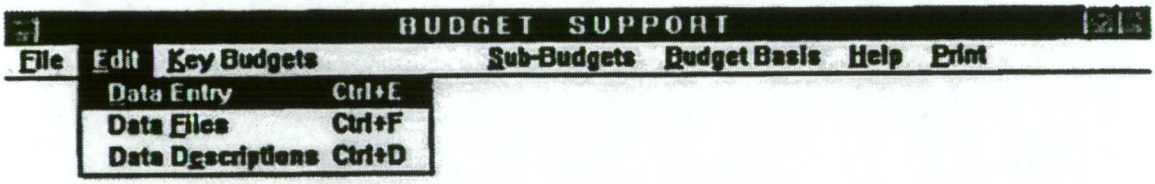



**Figure 34 Budget Support main menu.**

However in the case of the data file, a .TXT file, having been located it is now only necessary to select that file to enter that file into the main Budget Support program.

In the case of the DATA ENTRY spreadsheet program, having entered the spreadsheet, a reference number may be used in conjunction with EDIT at the top of the spreadsheet and then highlighting FIND to access a particular set of data in the spreadsheet. Reference numbers can be found within the EDIT menu by clicking on DATA DESCRIPTIONS. Each description item in the Note Pad which appears includes a reference number.

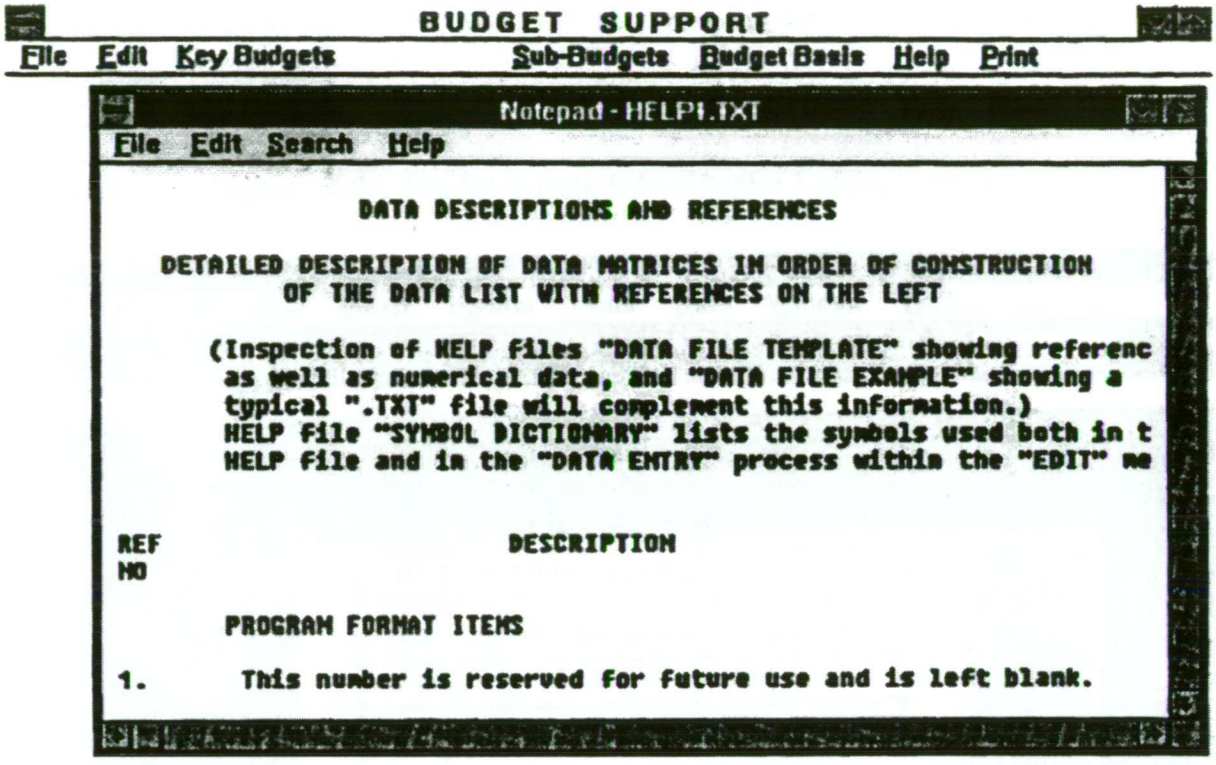



**Figure 35 shows the start of a data description and reference file used for locating the numbers of each main set of data.**

The opening screen of the data entry file is shown as figure 36. Instructions are provided to enable the data to be changed as required so that new budgets can be prepared at any time with the data of earlier budgets kept as .TXT files for reference if necessary.

In the case of data review, or the entry of a new set of data, it is vital that the data be entered first into this ".XLS" spreadsheet file system, ie. into the program you will be entering on clicking DATA ENTRY within the EDIT menu or by clicking on the icon BUDGET SUPPRT – Data Entry after highlighting BUDGET. While an ".XLS" file covers all the instructions and details of the data entry process, the final ".TXT" file, produced by this data entry process, contains only the numbers of the data.

While an ".XLS" file can be used to make a ".TXT" file the reverse is not the case. Therefore to update a ".TXT" file quickly and routinely, the ".TXT" files should not be used for up-

10 or REF 5. On clicking FIND NEXT the rectangular cursor moves directly to your destination to allow you to make an alternation. Movement up or down the file is achieved by use of Pg Up and Pg Dn.

Some entries of the data files should not be changed. Their default value is noted in the explanatory information to the right of the spreadsheet. Unless all data slots are filled, either from the past or currently including both default and new data items, the WRITE TO FILE function will not operate. A search is then required to allow entry of the missing information and thus enable the data to be transferred to a ".TXT" file.

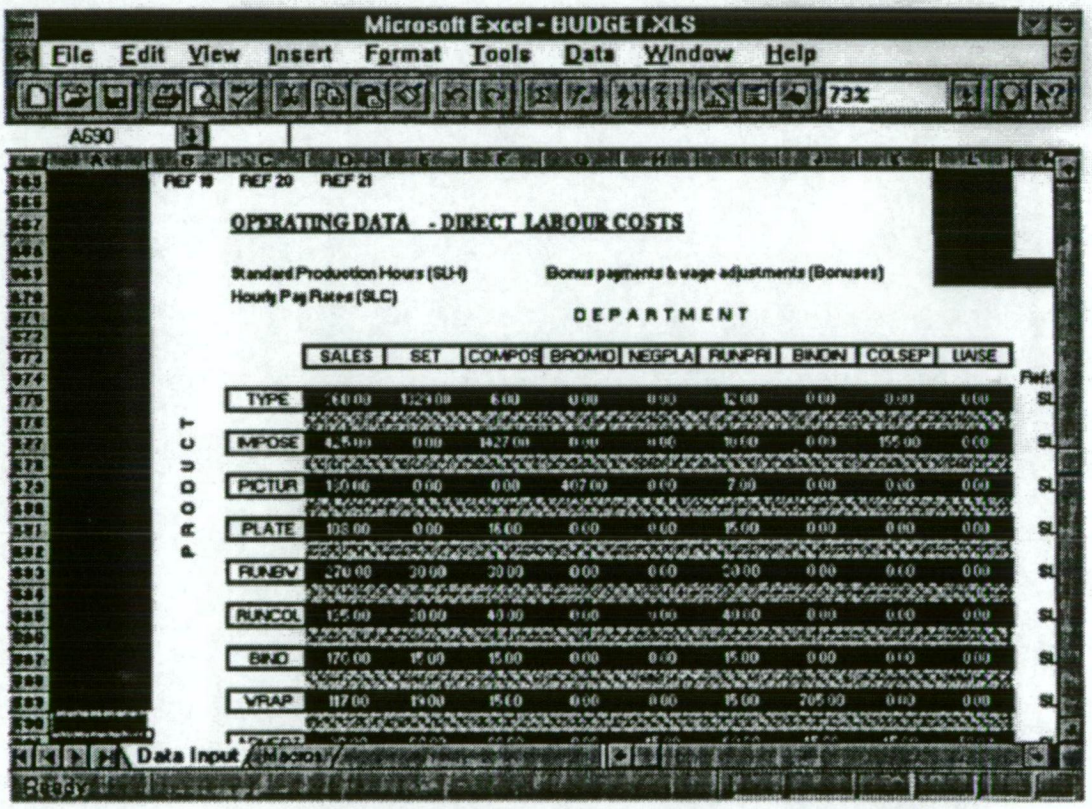



**Figure 37 Typical data entry screen in an .XLS program.**

### 4.2.1.4 Presentation of key budgets

Having entered the data from a .TXT file into the program then upon selection of the menu shown in figure 38 two options are presented. First is KEY BUDGETS and the second is BUDGET NOTES.

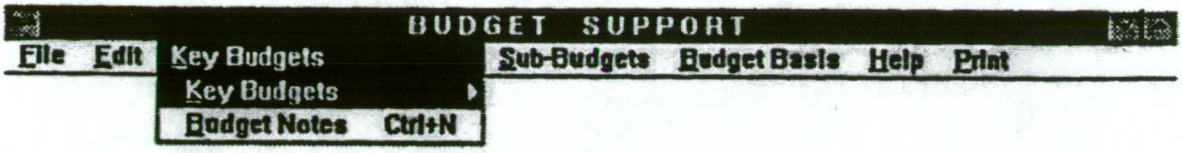



Figure 38 Key budgets pull down menu

The following budgets become available

| | |
|---|---|
| SALES | BALANCE SHEET |
| MATERIALS | FUNDS MOVEMENT |
| LABOUR (by department) | PRICES AND MARGINS |
| FACTORY OVERHEADS | FINANCIAL RATIOS |
| ADMINISTRATION | PRODUCT COSTS |
| CASH FLOW | HOURLY RATES |
| PROFIT AND LOSS | |

The key operating budgets are shown as figure 39.

The cash budget and financial ratios of the key budgets have already been included as figure 17.in section 2.5.4.1. The major control budgets in addition to the cash flow – the profit and loss and balance sheets – are included as figure 40.

By moving to the sub budgets menu figure 41 it is possible to get progressive budgets of profit and loss, balance sheets, funds movement , prices and margins.

As an ancillary set of information to the sub budgets, a budget basis folder is provided which enables key input data and production targets to be examined. The important aspect of this from a management point of view is to be able to examine the various targets in terms of the units to be produced as distinct from the dollar value.

## Sales

BUDGET SUPPORT

File Edit Key Budgets Sub-Budgets Budget Basis Help Print

**Monthly Sales Volume ($000s)**

| PRODUCT | 1996/7 | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TYPE | 54.000 | 1.404 | 5.184 | 6.264 | 3.024 | 4.320 | 4.320 | 5.724 | 5.076 | 5.076 | 4.536 | 4.536 | 4.536 |
| IMPOSE | 38.500 | 1.001 | 3.696 | 4.466 | 2.156 | 3.080 | 3.080 | 4.081 | 3.619 | 3.619 | 3.234 | 3.234 | 3.234 |
| PICTUR | 12.100 | 0.315 | 1.162 | 1.404 | 0.678 | 0.968 | 0.968 | 1.283 | 1.137 | 1.137 | 1.016 | 1.016 | 1.016 |
| PLATE | 36.300 | 0.944 | 3.485 | 4.211 | 2.033 | 2.904 | 2.904 | 3.848 | 3.412 | 3.412 | 3.049 | 3.049 | 3.049 |
| RUNBW | 78.200 | 2.033 | 7.507 | 9.071 | 4.379 | 6.256 | 6.256 | 8.293 | 7.351 | 7.351 | 6.569 | 6.569 | 6.569 |
| RUNCOL | 16.320 | 0.424 | 1.567 | 1.893 | 0.914 | 1.306 | 1.306 | 1.730 | 1.534 | 1.534 | 1.371 | 1.371 | 1.371 |
| BIND | 28.139 | 0.672 | 2.707 | 3.271 | 1.579 | 2.256 | 2.256 | 2.989 | 2.651 | 2.651 | 2.369 | 2.369 | 2.369 |
| WRAP | 93.750 | 2.438 | 9.000 | 10.875 | 5.250 | 7.500 | 7.500 | 9.938 | 8.813 | 8.813 | 7.875 | 7.875 | 7.875 |
| ADVERT | 23.000 | 0.598 | 2.208 | 2.668 | 1.288 | 1.840 | 1.840 | 2.438 | 2.162 | 2.162 | 1.932 | 1.932 | 1.932 |
| Totals: | 380.309 | 9.829 | 36.516 | 44.123 | 21.301 | 30.430 | 30.430 | 40.319 | 35.755 | 35.755 | 31.951 | 31.951 | 31.951 |

## Materials

BUDGET SUPPORT

File Edit Key Budgets Sub-Budgets Budget Basis Help Print

**Materials Purchase Volume ($000s)**

| MATERIALS | 1996/7 | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PAPER | 39.174 | 3.487 | 3.447 | 3.487 | 3.212 | 3.917 | 3.369 | 1.920 | 3.173 | 3.526 | 3.134 | 3.291 | 3.212 |
| PHOTOS | 1.765 | 0.159 | 0.157 | 0.159 | 0.146 | 0.179 | 0.154 | 0.088 | 0.145 | 0.161 | 0.143 | 0.150 | 0.146 |
| PLATES | 27.082 | 2.410 | 2.383 | 2.410 | 2.221 | 2.709 | 2.329 | 1.327 | 2.194 | 2.437 | 2.167 | 2.275 | 2.221 |
| PRINTG | 47.675 | 4.243 | 4.195 | 4.243 | 3.909 | 4.768 | 4.100 | 2.336 | 3.862 | 4.291 | 3.814 | 4.005 | 3.909 |
| BINDNG | 20.463 | 1.821 | 1.801 | 1.821 | 1.678 | 2.046 | 1.760 | 1.003 | 1.658 | 1.842 | 1.637 | 1.719 | 1.678 |
| WRAP | 63.858 | 5.683 | 5.619 | 5.683 | 5.236 | 6.386 | 5.492 | 3.129 | 5.173 | 5.747 | 5.109 | 5.364 | 5.236 |
| ED&SEP | 10.092 | 0.898 | 0.888 | 0.898 | 0.828 | 1.009 | 0.868 | 0.495 | 0.818 | 0.908 | 0.807 | 0.848 | 0.828 |
| Totals: | 210.129 | 18.701 | 18.491 | 18.701 | 17.231 | 21.013 | 18.071 | 10.296 | 17.021 | 18.912 | 16.810 | 17.651 | 17.231 |

## Labour

BUDGET SUPPORT

File Edit Key Budgets Sub-Budgets Budget Basis Help Print

**Labour by Dept. per month ($000s)**

| DEPARTMENTS | 1996/7 | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SALES | 25.214 | 2.244 | 2.219 | 2.244 | 2.068 | 2.521 | 2.874 | 0.530 | 2.042 | 2.269 | 2.017 | 2.118 | 2.068 |
| SET | 20.021 | 1.782 | 1.762 | 1.782 | 1.642 | 2.002 | 2.282 | 0.421 | 1.622 | 1.802 | 1.602 | 1.682 | 1.642 |
| COMPOS | 21.722 | 1.933 | 1.911 | 1.933 | 1.781 | 2.172 | 2.476 | 0.456 | 1.759 | 1.955 | 1.738 | 1.825 | 1.781 |
| BROMID | 5.494 | 0.489 | 0.484 | 0.489 | 0.451 | 0.549 | 0.626 | 0.115 | 0.445 | 0.495 | 0.440 | 0.462 | 0.451 |
| NEGPLA | 0.608 | 0.054 | 0.053 | 0.054 | 0.050 | 0.061 | 0.069 | 0.013 | 0.049 | 0.055 | 0.049 | 0.051 | 0.050 |
| RUNPRI | 2.754 | 0.245 | 0.242 | 0.245 | 0.226 | 0.275 | 0.314 | 0.058 | 0.223 | 0.248 | 0.220 | 0.231 | 0.226 |
| BINDIN | 10.125 | 0.901 | 0.891 | 0.901 | 0.830 | 1.013 | 1.154 | 0.213 | 0.820 | 0.911 | 0.810 | 0.850 | 0.830 |
| COLSEP | 2.700 | 0.240 | 0.238 | 0.240 | 0.221 | 0.270 | 0.308 | 0.057 | 0.219 | 0.243 | 0.216 | 0.227 | 0.221 |
| Totals: | 88.637 | 7.889 | 7.800 | 7.889 | 7.268 | 8.864 | 10.104 | 1.862 | 7.180 | 7.977 | 7.091 | 7.446 | 7.268 |

## Factory Overheads

BUDGET SUPPORT

File Edit Key Budgets Sub-Budgets Budget Basis Help Print

**Factory Overheads ($000s)**

| O.H. DEPTS | 1996/7 | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUPERV | 2.407 | 0.209 | 0.207 | 0.209 | 0.199 | 0.224 | 0.244 | 0.113 | 0.197 | 0.210 | 0.196 | 0.202 | 0.199 |
| RENT&P | 5.400 | 0.452 | 0.452 | 0.452 | 0.450 | 0.457 | 0.462 | 0.425 | 0.449 | 0.453 | 0.449 | 0.450 | 0.450 |
| FACINT | 2.684 | 0.225 | 0.225 | 0.225 | 0.223 | 0.227 | 0.229 | 0.212 | 0.223 | 0.225 | 0.223 | 0.224 | 0.223 |
| REPAIR | 4.215 | 0.358 | 0.357 | 0.358 | 0.350 | 0.371 | 0.368 | 0.276 | 0.348 | 0.359 | 0.347 | 0.352 | 0.350 |
| FACDEP | 16.757 | 1.401 | 1.400 | 1.401 | 1.395 | 1.409 | 1.420 | 1.349 | 1.395 | 1.401 | 1.394 | 1.397 | 1.395 |
| VEHDEP | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| BLGDEP | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Totals: | 31.463 | 2.644 | 2.640 | 2.644 | 2.617 | 2.688 | 2.743 | 2.375 | 2.613 | 2.648 | 2.609 | 2.625 | 2.617 |

## Administration

BUDGET SUPPORT

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**Administrative Expenses**

| Product | Total | Fixed | Var. | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADMSAL | 8.614 | 8.500 | 0.114 | 0.003 | 0.011 | 0.013 | 0.006 | 0.009 | 0.009 | 0.012 | 0.011 | 0.011 | 0.010 | 0.010 | 0.010 |
| ACCALE | 1.600 | 1.600 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| SUPER | 2.500 | 2.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PHONES | 2.500 | 2.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| BANK | 2.500 | 2.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TRAVEL | 6.636 | 6.500 | 0.136 | 0.004 | 0.013 | 0.016 | 0.008 | 0.011 | 0.011 | 0.015 | 0.013 | 0.013 | 0.012 | 0.012 | 0.012 |
| OFFICE | 2.500 | 2.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| BADDBT | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Totals: | 26.850 | 26.600 | 0.252 | 0.007 | 0.024 | 0.029 | 0.014 | 0.020 | 0.020 | 0.027 | 0.024 | 0.024 | 0.021 | 0.021 | 0.021 |

Figure 39 The main operating budgets produced by the program.

# Profit & Loss

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**Projected Profit and Loss for the Year 1996/7 (in $000)**

| | | | | Totals |
|---|---|---|---|---|
| Total Sales Volume | | | 380.309 | 380.309 |
| Total Direct Material Purchases | 210.128 | | | |
| Plus Opening Material Inventory | 23.986 | | | |
| Less Closing Material Inventory | 23.987 | | | |
| Total Direct Material Cost | | 210.129 | | |
| Total Direct Labour Cost | | 88.637 | | |
| Total Factory Overheads | | 31.463 | | |
| Opening [Partly] Finished Goods | 36.746 | | | |
| Less Closing Finished Goods | 33.834 | | | |
| Finished Stock Adjustment | | 2.912 | | |
| Less Factory Cost of Goods Sold | | | | 333.140 |
| Gross Margin | | | | 47.169 |
| Total Administration Expenses | | 26.850 | | |
| Net Financial and Miscellaneous | | 2.917 | | |
| Less Total Net Costs | | | 362.907 | |
| Net Profit Before Taxes | | | 17.402 | |
| Less Company Tax [Estimated] | | | 6.265 | |
| Profit After Taxes for 1996/7 | | | | 11.137 |

# Closing Balance Sheet

BUDGET SUPPORT

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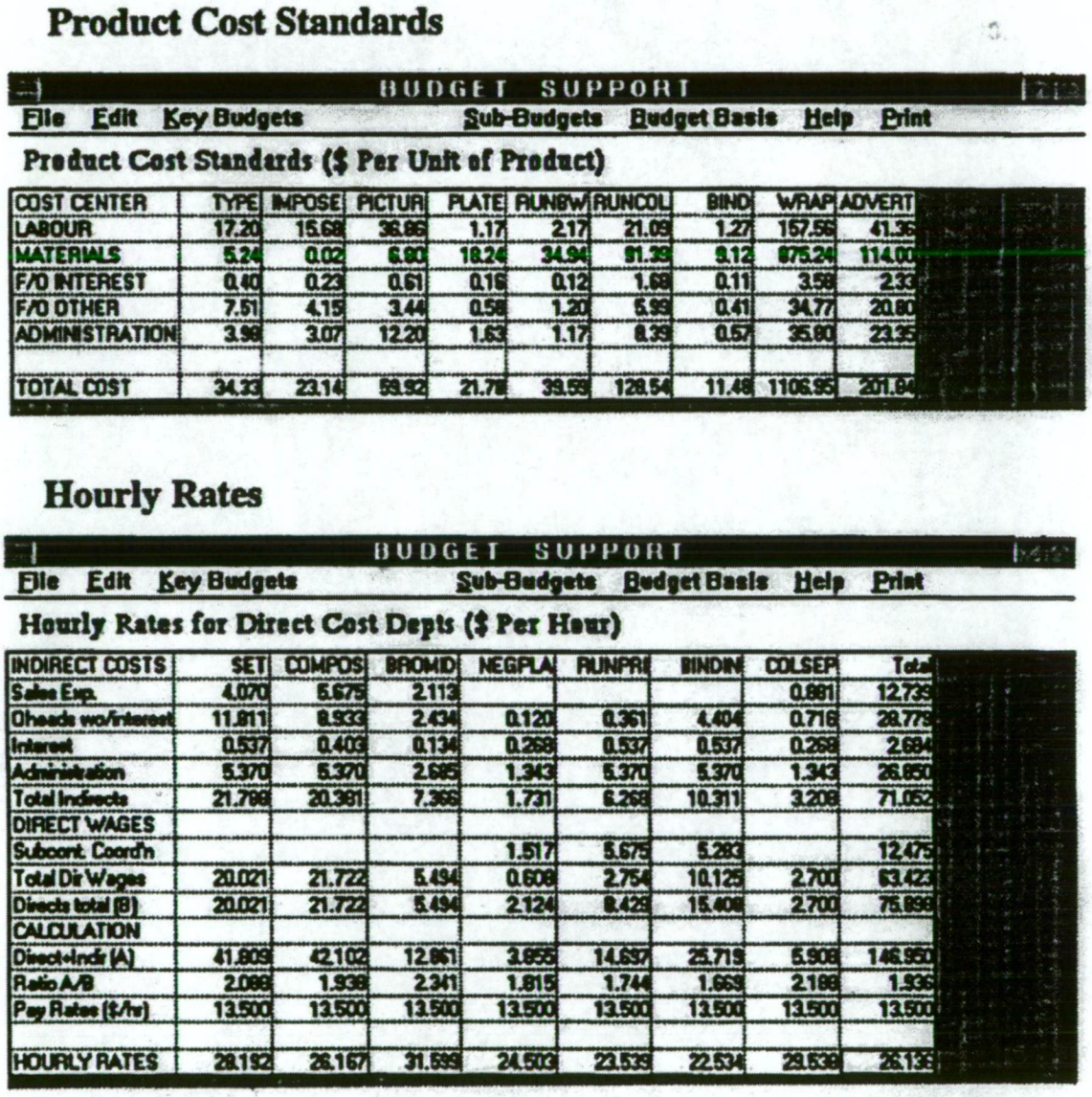
**Closing Balance Sheet for the Year 1996/7 (in $000)**

| | | Assets | | | Liabilities | |
|---|---|---|---|---|---|---|
| Cash on Hand/In Bank | | 32.455 | | | | |
| Short Term Securities | | 0.000 | | Short Term Loans | -0.006 | |
| Accounts Receivable | 53.896 | | | Accounts Payable | 28.426 | |
| Less Allowances | 0.500 | | | Accrued Expenses | 0.810 | |
| Net After Allowances | | 53.396 | | Total Short Term Liabilities | | 29.230 |
| Material Inventory | | 23.987 | | | | |
| [Partly] Finished Goods | | 33.834 | | | | |
| Prepaid Expenses | | 2.035 | | | | |
| Total Current Assets | | | 145.707 | Total Long Term Liabilities | | 10.729 |
| Participations and Investments | | | 33.726 | | | |
| Equipment and Machinery | 135.369 | | | | | |
| Less Allowances | 16.757 | | | | | |
| Net After Allowances | | 118.612 | | | | |
| Holdings of Land | 0.000 | | | | Net Funds | |
| Buildings and Fixtures | 0.000 | | | Share Capital | 40.000 | |
| Less Allowances | 0.000 | | | Share Holder Loans | 188.669 | |
| Net After Allowances | | 0.000 | | Retained Earnings | 29.418 | |
| Total Fixed Assets | | | 118.612 | Owners Equity | | 258.087 |
| Total Assets | | | 298.045 | Total Funds | | 298.045 |

**Figure 40 A typical profit and loss and balance sheet for a company. Detailed results for example, by month as against per annum, can be obtained using the sub budget program.**

Finally the standards which have proved useful for costing and quotations are shown as figure 41. The cost standards in this case are based on the units of each component produced, whereas the hourly rates are based on the departmental dollars per hour.

Separate software programs have been developed to enable the standards available from figure 41 to be used for pricing and production planning programs for small businesses.



**Product Cost Standards**

BUDGET SUPPORT

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**Product Cost Standards ($ Per Unit of Product)**

| COST CENTER | TYPE | IMPOSE | PICTUR | PLATE | RUNBW | RUNCOL | BIND | WRAP | ADVERT |
|---|---|---|---|---|---|---|---|---|---|
| LABOUR | 17.20 | 15.68 | 36.86 | 1.17 | 2.17 | 21.09 | 1.27 | 157.56 | 41.36 |
| MATERIALS | 5.24 | 0.02 | 6.80 | 18.24 | 34.94 | 91.39 | 9.12 | 875.24 | 114.00 |
| F/O INTEREST | 0.40 | 0.23 | 0.61 | 0.16 | 0.12 | 1.68 | 0.11 | 3.58 | 2.33 |
| F/O OTHER | 7.51 | 4.15 | 3.44 | 0.58 | 1.20 | 5.99 | 0.41 | 34.77 | 20.80 |
| ADMINISTRATION | 3.98 | 3.07 | 12.20 | 1.63 | 1.17 | 8.39 | 0.57 | 35.60 | 23.35 |
| | | | | | | | | | |
| TOTAL COST | 34.33 | 23.14 | 59.92 | 21.78 | 39.59 | 128.54 | 11.48 | 1106.95 | 201.84 |

**Hourly Rates**

BUDGET SUPPORT

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**Hourly Rates for Direct Cost Depts ($ Per Hour)**

| INDIRECT COSTS | SET | COMPOS | BROMID | NEGPLA | RUNPRI | BINDIN | COLSEP | Total |
|---|---|---|---|---|---|---|---|---|
| Sales Exp. | 4.070 | 5.675 | 2.113 | | | | 0.881 | 12.739 |
| Oheads wo/interest | 11.811 | 8.933 | 2.434 | 0.120 | 0.361 | 4.404 | 0.716 | 28.779 |
| Interest | 0.537 | 0.403 | 0.134 | 0.268 | 0.537 | 0.537 | 0.268 | 2.694 |
| Administration | 5.370 | 5.370 | 2.685 | 1.343 | 5.370 | 5.370 | 1.343 | 26.850 |
| Total Indirects | 21.788 | 20.381 | 7.366 | 1.731 | 6.268 | 10.311 | 3.208 | 71.052 |
| DIRECT WAGES | | | | | | | | |
| Subcont. Coord'n | | | | 1.517 | 5.675 | 5.283 | | 12.475 |
| Total Dir Wages | 20.021 | 21.722 | 5.494 | 0.608 | 2.754 | 10.125 | 2.700 | 63.423 |
| Directs total (B) | 20.021 | 21.722 | 5.494 | 2.124 | 8.429 | 15.408 | 2.700 | 75.898 |
| CALCULATION | | | | | | | | |
| Direct+Indir (A) | 41.809 | 42.102 | 12.861 | 3.855 | 14.697 | 25.719 | 5.908 | 146.950 |
| Ratio A/B | 2.088 | 1.938 | 2.341 | 1.815 | 1.744 | 1.669 | 2.188 | 1.936 |
| Pay Rates ($/hr) | 13.500 | 13.500 | 13.500 | 13.500 | 13.500 | 13.500 | 13.500 | 13.500 |
| | | | | | | | | |
| HOURLY RATES | 28.192 | 26.167 | 31.599 | 24.503 | 23.539 | 22.534 | 29.539 | 26.139 |

**Figure 41 Showing product cost and hourly rate standards**

Another display of value to marketing and financial planning are the prices and margins and funds movement statement of figure 42 the final budget displays of the program.

## Funds Movement

BUDGET SUPPORT

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**Funds Movement Statement for the Year**

| | | Assets | | | Liabilities | |
|---|---|---|---|---|---|---|
| Cash on Hand/In Bank | | 26.615 | | | 0.000 | |
| Short Term Securities | | 0.000 | | Short Term Loans | -9.000 | |
| Accounts Receivable | -4.710 | | | Accounts Payable | 1.394 | |
| Less Allowances | 0.000 | | | Accrued Expenses | 0.405 | |
| Net After Allowances | | -4.710 | | Total Short Term Liabilities | | -7.201 |
| Material Inventory | | 0.000 | | | | |
| (Partly) Finished Goods | | -2.912 | | | | |
| Prepaid Expenses | | -1.900 | | | | |
| Total Current Assets | | | 17.193 | Total Long Term Liabilities | | 0.000 |
| Participations and Investments | | | 0.000 | | | |
| Equipment and Machinery | 3.500 | | | | | |
| Less Allowances | 16.757 | | | | | |
| Net After Allowances | | -13.257 | | | | |
| Holdings of Land | 0.000 | | | | Net Funds | |
| Buildings and Fixtures | 0.000 | | | Share Capital | 0.000 | |
| Less Allowances | 0.000 | | | Share Holder Loans | 0.000 | |
| Net After Allowances | | 0.000 | | Retained Earnings | 11.137 | |
| Total Fixed Assets | | | -13.257 | Owners Equity | | 11.137 |
| Total Assets Movement | | | 3.936 | Total Liab & Equity Movement | | 3.936 |

## Prices & Margins

BUDGET SUPPORT

File Edit Key Budgets Sub-Budgets Budget Basis Help Print

**Prices and Margins for the Year**

| PRODUCT | Production Qty (Units) | Sales Qty (Units) | Factory Unit Cost | Adminis. Unit Cost | Sales Price Budget | Sales Price for Target | PRICE Variance | Fact Cost Bef Admin | Sales Value |
|---|---|---|---|---|---|---|---|---|---|
| TYPE | 1279.700 | 1350.000 | 0.03431 | 0.00330 | 0.04000 | 0.04060 | -0.00060 | 45.623 | 54.000 |
| IMPOSE | 1679.700 | 1750.000 | 0.01874 | 0.00179 | 0.02200 | 0.02205 | -0.00005 | 32.195 | 38.500 |
| PICTUR | 197.220 | 220.000 | 0.06022 | 0.00506 | 0.05500 | 0.05256 | 0.00244 | 9.650 | 12.100 |
| PLATE | 1483.300 | 1650.000 | 0.01963 | 0.00152 | 0.02200 | 0.02476 | -0.00276 | 34.091 | 36.300 |
| RUNBW | 1945.930 | 2200.000 | 0.03618 | 0.00315 | 0.03400 | 0.03618 | -0.00218 | 69.450 | 79.200 |
| RUNCOL | 138.420 | 160.000 | 0.12221 | 0.00923 | 0.10200 | 0.12313 | -0.02113 | 16.441 | 16.320 |
| BIND | 2243.680 | 2250.000 | 0.01080 | 0.00098 | 0.01197 | 0.01246 | -0.00049 | 24.430 | 28.139 |
| WRAP | 72.980 | 75.000 | 1.08387 | 0.10055 | 1.25000 | 1.26232 | -0.01232 | 79.007 | 93.750 |
| ADVERT | 88.530 | 115.000 | 0.22176 | 0.02033 | 0.20000 | 0.23186 | -0.03186 | 22.252 | 23.000 |

**Figure 42 Funds movement statement and prices and margins analysis.**

### 4.2.2 Operating the Program to establish and regularly Review Budgets and Operating Standards

#### 4.2.2.1 Responsibility

First there is the responsibility for initiating regular budget meetings[47] and seeing that preparatory information for the meetings has been coordinated. This function is outlined in 4.2.2.2 below. As part of this procedure the management philosophy, objectives and policies of the company need emphasis. For example accent may be placed on quality, participation, profits, security or growth. Second is the need to define who is to be responsible for design and maintenance of the system as set out in 4.2.2.3 below. This person is responsible for checking on changes within the firm, its products and personnel as well as liaison with the accounts department which measures performance. Auditing of the system's integrity is another important function of this executive.

#### 4.2.2.2 Budget meetings

The person responsible for budgets needs to have authorised the establishment of a working model of the firm and defined who is to check each of the budgets and their components against past and current actual performance. The preparation of a revised budget is a much quicker task than the initial establishment of the model and can take place at, or shortly after, a budget meeting. These meetings should be called regularly to discuss progress and iron out problems as part of an on going improvement strategy and management procedure. The budget coordinator should keep a copy of each set of budgets for reference. Minutes of these meetings should be
kept and proposed action recorded, in particular who is responsible for action in each instance.

The following management areas usually repay particular attention given to them:

1. First there is the need for a review of the effect of any organisation chart changes and to assess whether the products and subassemblies have changed in emphasis. Have new major sub-assemblies been introduced? This item can lead to review of the fraction to be applied as a multiplier to each past subassembly quantity to estimate the sales and then the production quantities of the new budget having regard to stock policies. Changes in

industry demand and product design can alter the proportion of subassemblies to be produced to meet sales targets and hence the quantity of materials to complete each sub-assembly unit.

2. Departments may have contracted or expanded and capital investment plans may have altered the staff hours of each producing and service department, so that a check on all labour hours allocated and total wages expected is a typical next step.
3. Inflation, interest rates or world economic pressures and prospects can alter raw material costs and the prices likely to be obtained for each component in a competitive market. These should now be checked.
4. Of continual importance is the final budgeted percentage of sales dollars of all direct purchases. Compare this figure with that of recent years. The margin over direct external purchases will vary substantially depending on whether the firm is horizontally or vertically integrated and the extent of automation involved. However within any one firm it is liable to be relatively constant from year to year unless the policy of the company has radically changed.
5. A comparison between current factory overhead totals and administration costs and those of the immediate past year is now recommended with a particular emphasis on predominant items within the particular business concerned. Such items as repairs, depreciation, interest and salaries usually repay careful examination.
6. Trading terms need to be checked, particularly the rate of debtor receipts and creditor payments as part of an office department analysis of these items. Is bank accommodation sufficient having regard to the calculated cash flow needs covering future plans and obligations? Check and if necessary revise the cash flow budget and the stock position by altering the timing of capital expenditure or rates of payment for example. See that the margins analysis shows an adequate cover for each sub-assembly on top of all materials, wages and factory overheads costs.
7. Technology, training and maintenance need to ensure that current equipment is efficient and satisfactory for the future potential of the industry. Authorisation of feasibility studies to check the potential of new local or overseas plant and processes may be justified.

8. Investigation of any anomalies raised as a result of preliminary runs of the program. Keep a copy of the previous budget untouched for safety and use it to work through the data entry system to establish any new budgets.

With the profit and loss statements and balance sheets looking to be in line with the latest plans it is now useful to print out all the budgets, including the cash budget, information sheets and standards, making notes on any changes needed. Recognise that any change made usually alters other items contingent upon the items changed and therefore the effect of changes should be fully assessed before finalising your budget.

For example as pointed out above appraisal of the cash budget may lead to the need to alter the priority given to capital expenditure plans, the rate of creditor payments or point to the need to attend to the accounts receivable proposals. Of course the firm, its customers and suppliers should, as far as possible, be fully behind the data entered into the final budget. This need can lead to important discussions with all concerned.

Analysis of the price margins for each product in conjunction with the cost standards and hourly rates can reveal the need for pricing review. Examination of the funds movements may emphasise a need to review debtor or creditor relationships and a consideration of investment policies in line with future growth. The extent to which depreciation balances capital expenditure and contributes to cash flow needs to be clearly understood.

Part of this budget review and company development process are meetings, discussions and agreements with those responsible for implementing the budget. From board room to shop floor, input and comment are important if the master plans of this budget support program and the management of which it is a part are to be fully effective.

#### 4.2.2.3 Maintenance procedures

Major items which should receive regular attention by the person responsible for budget maintenance are:

- Attendance at regular meetings of all key personnel to discuss actual results compared with the budget, including market research data, and to implement any necessary corrective action. These include budget changes if justified by changed economic circumstances as part of the actual performance comparison with that expected in the budget.
- Review of the budget data in the light of the meetings discussions, new circumstances, new organisation structure and new destinations for information. Check the distribution of hard copy and computer screen information. Watch for new descriptions of products and subassemblies, changes in descriptions of materials and operating and costing departments as well as the tax expected for the company. Should the company move to be substantially involved in sub-contracting it may be necessary to allocate part of the direct labour to supervision as an overhead in the hourly rate calculation. In general the budget coordinating person should be able to answer queries as to how the budget program works.
- Check the alignment of the traditional accounts system categories with those of the budget support system to ensure that the comparison program truly indicates when a situation needs attention.
- Regularly check the prices actually charged in relation to the cost standards and margins analysis of the budget support system as well as the application of the standards to the workload calculations used for production planning.
- Keep back up files and hard copy of the whole of the computer and systems data and relevant programs together with records of results to enable reentry into the computer should a breakdown take place or virus protection fail.
- Add comments and new information specially relevant to one's company, to the manual to assist understanding within the firm and improve communication for current and future users and maintainers of the system.

## 4.3 CASE STUDIES CONCERNING THE APPLICATION OF THE BUDGET SUPPORT PROGRAM

Case studies are presented in this section which demonstrate both the successful application of the Budget Support system and the need for wider management knowledge across their profession by many engineering groups. In section 4.3.1 the historical development of the program is outlined and its application in a company explained, including the use of the company as a laboratory for improvement, for long term planning and the company's technical, management and commercial development.

The next section 4.3.2 deals with the successful application of the system as a method of carrying out a feasibility studies in which critical "what if " questions concerning the future of two diverse enterprises were carried out directly leading to answers to important business decisions.

Section 4.3.3 explains how detailed analysis of the model and its use in actual decision making involving industrial and commercial applications has been an aid to business training of mechanical, manufacturing and industrial engineering students in their final year at a university.

The final case study 4.3.4 discusses the response received to the work of the author in establishing a periodical for the widening of the management horizons of professional engineers of the Societies of the Institution of Engineers Australia. The opportunity to address this need, so clearly demonstrated as important in chapters 2 and 3 of this thesis, and inform society members of fellow member's aptitudes and business skills, has been endorsed by manufacturing, industrial and maintenance engineers with additional contributions from allied engineering groups.

### 4.3.1 Observations on the Application and Development of the Program by Research Publications Pty Ltd, and its use in guiding the Company's Management.

#### 4.3.1.1 Comments on the development and application of the Budget Support simulation

As a general comment the program has enabled the firm to survive through times of major change in the economic and technological climate of the last thirty years. This has been due to the stimulus to decision making and forward prediction it promotes and the cost benefits it provides through calculating standard costs based on overall considerations. It gives a basis for pricing as well as a saving in time and money, in internal accounting costs and avoids the need for a hard sales approach. Feasibility studies to test capital expenditure proposals and their timing have made a valuable contribution to the company's development. While in retrospect the result has been satisfying, the cost of this research, and development of the simulation to its current state, has been costly in terms of administrative energy and time that would have normally been spent directly on company affairs. Papers presented locally, overseas and to IEAustralia meetings relevant to the Budget Model are included in appendix A and supervised papers in appendix B. A copy of the Budget Support manual and an installation disc are included as appendices D and E.

Some items of significance from a study of the model's development are:

1. The original program required complete print outs of all budgets to achieve an answer to one budget item since the program did not hold the answers as a selectable isolated budget. Each new run of data required a lapse of around two days on a major centralised computer. Modification to allow only partial printout was introduced but the whole process was still slow. The current speed of operation using a PC allows an immediate response and this allows individual departmental budgets to be shown immediately on the computer screen even though each one is recalculated using the same data and program as one moves from budget to budget.

2. In terms of practical application the model now works on the components of a product not the number of products. This allows a multitude of products to be accommodated

from a limited number of components. This also has advantages for costing and production planning. This concept is hard for some people to accept. An executive of a leading scientific research group demonstrated this blind spot, when he observed recently to the author that what we were doing was not possible, even though this method is currently working well in practice.

3. The original limitation on the number of "products" and "raw materials" , overheads and departments due to the inability of the computer's memory to cope with the storage of the intermediate calculations has now been changed because of the capacity of modern PC hardware and software so that the current program allows an automatic change in component numbers within limits. In practice it has been found that a limit on the number of alternatives is necessary to limit the focus of management to the most important budget issues. Currently Research Publications has moved from 9 components/products to 15. Should difficulty in selecting units for lesser items occur some of these components can be related to such units as labour hours, $ values, weights or areas to avoid too wide a range.

4. Some firms prefer to cost their work completely or partly on departmental hourly rates rather than overall standards of the company. An hourly rate is useful for costing the occasional unconventional "jobbing product". A matrix to allow this has therefore been introduced into the data, and software developed, to enable hourly rates to be calculated and used with material costs for costing and pricing purposes.

5. A matrix to define overhead distribution for costing has been introduced to allow the costing of components to be calculated accurately rather than just adding a common percentage for factory overheads and administration. This enables "fixed" charges such as depreciation and interest to be placed against the components which incur them. This is particularly important in the case of variations in the degree of automation throughout a plant.

6. To make the program more widely applicable and user friendly Visual Basic was chosen to provide a front end presentation to the program which was originally written in Fortran with ancillary programs in M Basic. This allowed a screen presentation and print out of individual budgets together with monthly and annual sub-budgets as explained in the draw down menu of reference [47] figure 33. In addition an explanation of the terms used and descriptions of the matrices is included in the Help part of the pull down menu. Access is also provided to and from the data assembly Excel program.

7. A separate Excel system was developed and integrated into the program suite. This was to assist in revising the data rather than having to find a particular matrix amongst columns of figures. This data assembly program describes each line of data. The data entered resides in easily identified blocks so that when one is satisfied with the data entered then only the data, not the descriptions, is transferred to a simulation data file to enable a budget to be run.

8. Some early modifications were provided as options to refine the calculations of labour costs by allowing calculation on a piece rate basis and being able to change the proportion of raw material charges when sales exceeded a certain level. These have proved unimportant at this stage as generally raw material costs applicable to each product and total labour costs have been better measured using the average unit material costs per component and predicted annual hours worked respectively in a particular company's forward plan.

9. Initial installation involves time to define and obtain agreement for names of components, raw materials and categories of accounts to enter into the data entry program as well as locate the initial numerical data. It has been found that patience and tact in collecting this information can give rise to management improvement quite apart from the budgeting process later. Debates can take place between the senior people of the organisation as to just what constitute the key components/products of the group, just what names and descriptions should apply throughout the company in future and

above all where is the company going in future. Part of this development process is to define who is responsible for coordinating budget opinions and which executives are to actively participate in the budget's preparation and implementation.

10. Maintenance of the program is in general much simpler than its initial establishment as far as the clerical updating process is concerned. The opening balance sheet is entered and the initial meeting's views of changes to the multipliers which determine expected forward production are posted and prices estimated over the year. After such data as capital expenditure and borrowing plans are entered a preliminary run is possible to receive comment on the total sales expected. Following this process any anomalies in stock values can be corrected, labour hours and costs per hour amended and raw materials purchase ratios and costs as well as assessment of the time they will be purchased entered. A check on the terms of trade and interest rates should now take place as well as a review of the overhead cost distribution matrices. Examination of the previous year's sub-totals to check the common sense of the results is advisable before their distribution, in particular to pick up any misplaced decimal points in the data. Finally let the budget participants examine the profit and loss, expected overdraft in the cash flow budget, the balance sheets and the resulting cost standards to check whether the plans proposed and the results are practical and meet the objectives of the organisation. Trials of alternative strategies proposed by participants is now an important part of this budgeting process if full support for the budget and its implementation is to be achieved.

11. An important point to watch when setting up the data for the simulation is to ensure that the immediate past real time production unit data is as accurate as possible. A conservative approach to the figures, that is, causing one to reduce them to be safe causes the final cost standards to be higher than necessary and can lead to prices higher than planned to meet competition. If this starting production figure is in excess of reality, standards will turn out to be lower than they should be. The answer is of course to ensure that there is in place an accurate production record system to record the output

of components and if accurate records are not readily available to calculate these figures carefully to provide a sound foundation for the program.

12. The simulation overcomes the problem of arbitrary estimation of labour time taken to produce a component by working back from the annual cost rather than use an estimate biased towards an individual estimator's skill or the enthusiasm of a sales person anxious for a sale. Similarly total materials are broken down into parts per component which automatically takes waste into account.

13. The manual [47] prepared by Research Publications contains the formal information concerning the basis of the program together with notes on its application and its advantages. It also sets out the administrative procedures recommended for its maintenance and wider use as a management information system.

#### 4.3.1.2 Historical

Before tracing the part played by Research Publications in the development of the Budget Support process and the contribution it has made to the firm's management, it is worth while outlining the history of the company. This company has been involved with this simulation process and used it as part of its development from shortly after the company's establishment in 1962.

**Initiation** Research publications was established to disseminate technical and research information between university / tertiary trained people and the community and business leaders responsible for the management of our medical, industrial and social services. Its objective was to break down the communication barrier between self made, less formally educated, people and those who had the advantage of advanced training in a wide range of professions. The formal backing of its aims and editorial content was by leaders in their professions of law, medicine, engineering and science at the universities of Melbourne and Sydney.

The result was a subscription based *Scientific Australian* magazine whose readers later became largely those who already had a tertiary education. The trained biologist, researcher or social scientist interested in the advances in solid state physics, space exploration, drug behaviour and archeological discoveries became a majority of readers. A world survey of technical magazine publishing including liaison with Scientific American's editor and encouragement of universities and CSIRO, looking for greater acceptance of their contribution to industry and society, assisted with contributions. However it was disappointing that such industrial leaders as BHP and ICI gave only lip service to support for the project. Later CSIRO took up aspects of this challenge by radically investing in and expanding their publishing division with a substantial staff increase and a wide range of technical publications. Research Publications therefore changed this part of their limited resources to continue their industrial liaison efforts through applied scientists and engineers with a *Science and Technology* magazine.

**Growth** During this early period it was discovered that if one passed technical editorial material into the printing industry at that time serious cost increases took place and many mistakes were made. These were the result of a hierarchical structure in which the messages were transferred down to an operator to prepare copy and back up again to reach an outside editor only to need correction again. It was decided therefore to buy typesetting, set up a printing machine and print the magazine in house and operate with a much more direct management structure. It was this decision which led to development of a printing, typesetting and binding operations at the start of an era of extraordinary technology change throughout the printing industry. Printing changed from letterpress to offset. Typesetting moved from linotype and hand compositing to photosetting. Colour reproduction from block making was replaced by colour separation techniques and scanning. Composition moved from hand compositing to paste-ups, to desktop publishing and movement direct to film.

All these changes were facilitated by having an engineering background. In fact a research grant was awarded to the company to develop photosetting equipment allied to a world survey of this technology. This was successfully developed and capitalised. Incidentally the equipment developed through this research subsequently proved popular in a separate

application in the school education field. The heavy investment in further printing, binding and prepress advances continued. This was combined with an adjustment of people responsibilities and structure to meet the needs of the technical and graphic communication services the firm provided. The skill the firm had developed in transferring technical information from one group to another within society turned out to be needed by the committees and members of many professional organisations using well presented, economically produced, periodicals to enable them to communicate with their fellow members. These clients covered such diverse fields as watch repair, operating theatres, credit management, rose growing, energy generation, geology, medical therapies, primary and tertiary education, testing and conference transactions and manufacturing and maintenance.

The budget programming procedures using a budget model operated in parallel with these activities. It contributed to the business planning of both the finances and facilities required to handle this technological transition and adjust to the growth in markets, production plant, staff skills and wage pressures as part of a vertically integrated operation. Vertical integration at a time of substantial wage inflation was chosen primarily to minimise the level of overheads charged by suppliers at the time of a seller's market for suppliers when Research Publications contracts were mostly on a long term fixed price basis.

**Consolidation** The application of the model's standards to pricing for magazines was adopted as a new technique for costing, and hence pricing of magazines by many printers within the local printing industry. Perhaps the most important effect from the use of the simulation process as part of management was the fact that it forced a regular review of practically every facet of the business and its forward policies. This process highlighted the need to be able to combine technical and business skills within the management of a company particularly at a time of rapid change in economic conditions and technological advance, a situation which continues to this day.

Publishing, as distinct from solely preparation services to clients, was carried out to promote interest in more than twenty regions of Australia with unique historical, cultural, geological and geographic backgrounds. This *See Australia* series helped promote interest in visiting

these areas and assisted in the work of regional information centres. There has recently been renewed interest in these more in-depth publications although there is strong competition from free promotion pamphlets produced by local advertisers and government agencies. At the same time repeat editions to recover the investment involved, following an initial successful publication requires loyalty from the regional purchaser and parochial politics often works against this. This example demonstrated again how careful engineers need to be in assessing the market for a product and the importance of finding out as early as possible the extent that people will pay for what is perceived ahead of schedule by an engineer to be a valuable service.

**Restructure** Three main pressures for further change developed during the last decade. First, a new economic climate was emerging in which the company was moving to a much stronger position as far as buying its print machining and binding services. A buyer's market was developing so that horizontal integration would be more efficient. Second, to be competitive in printing and binding, much greater capital would be required with much stronger print supervision and better print quality. Third, the principal skill of the company was focussed on the communications and prepress work but this area would also require substantial funds in computer software and hardware and development of further prepress skills to compete in future.

In these circumstances the forward planning budgets showed that it would be more profitable and satisfying to the staff to sell off the printing and binding activities and concentrate on the front end of the business in a less costly premises. Part of the capital recovered through this action was to be used to invest in prepress technology and the remainder used to make the company debt free. A preliminary effort to combine these plans with a printer who was to take over the print supervision and rationalise the equipment needed was not successful. The master plan just outlined and developed using the budget planning system was then successfully implemented to bring the company to its present day position and achieve the benefits envisaged by the budgeted horizontally integrated new structure.

**The future** The current situation of the firm is therefore very different to that of the highly geared and orthodox trade orientation of the past. Although it is still strongly service orientated it now has few external borrowings or liens, has a profit and relative security. Two recent ventures point to one of the important considerations in development and long term planning. These are periodicals to assist primary teachers and engineers in industry and commerce. Both the periodicals now being developed for these professions by the company have taken around ten years from the initial identification of the market to the point where investment and a solid foundation would be advisable and have a reasonable chance of success. It is therefore insufficient to just locate a need , the timing of entry into the market has to be at a time when pressure groups associated with that need are ready to embrace a new initiative. As some of the earlier ventures of this company were ahead of their time the lesson is that it is important to include adequate market survey costs in the budget as an insurance against over optimistic sales estimates.

Technology challenges such as wise use of Email and the web and the potential for financing computer output directly to the printing plate are just some of the questions now before the company. Staff changes due to retirements will need to take into account new methods of operation and balance participatory management with future financial and technology guidance. The access to the control information and standards economically produced through Budget Support will continue to keep management, accounting and estimating costs down and highlight planning needs.

Information and networking needs within the professions and between them are as important as they were more than thirty years ago when the firm was founded by the author. The market is still there but the firm must keep on top of any emerging channels capable of meeting this need more effectively or more economically.

**Conclusion** This case study has demonstrated the accuracy, authenticity and value of the Budget Support system as a vehicle for forward planning and effective engineering management within a technology orientated manufacturing organisation and is therefore recommended for wide use in this context.

### 4. 3. 2 Budget program applied to a Pastoral Company and a Quarry Drilling Company

Two of the projects carried out during the early stages in the development of the program were both successful in that they clarified a management dilemma and facilitated practical decision making. The budget support planning proved valuable in both cases as an investigative tool to define the best path to follow in future and assist the proprietors to understand their own businesses.

**Pastoral case**

A simulation was carried out of the activities of a pastoral company next to the Hume Highway between Holbrook and Tarcutta in New South Wales. The products were sheep meat, wool, cattle meat and crops. The data was arranged to include the names of the products, purchases and traditional accounts categories as well as standard wages for supervision and operations. Balance sheet items were set out and trading terms which are so critical in farming noted.

The question needing clarification was a proposal by an agronomist, an gricultural/economics consultant, that the proprietors of the farm should invest in a very substantial purchase of an additional large earth mover and arrange for the clearing of a further large area of the hill country of their land to improve its total stock carrying capacity. This suggestion was made at a time when the popular media were pushing the idea that one had to get bigger at all costs to survive. It was considered by the agronomist that all that was needed was his recommendation to the bank and finance based on increasing the farm's mortgage would be available. The proprietors had a strong resistance to further debt and wanted the real benefits to be assessed and a check made as to whether there were any better alternatives.

First it should be pointed out that in this case the farm was run by people with excellent husbandry and veterinary skills who believed in both development and living within their means. It is also important to recognise that the prices obtainable from farm output is largely out of the hands of farmers being primarily dependent on world markets and macro-economics.

Having inserted current operating data into the model the simulation was run and examined to check that income and costs were representative of the farm as it was prior to any change. Inserting into the data the proposed investment in plant, more stock and labour to clear the land as well as the expected changes in output as a result, the effect of the plan was determined. The return and cash flow resulting from the change were clearly unsatisfactory. However the discussions and investigation clarified as part of any plan, the question of total capacity of the farm in terms of "Dry Sheep Equivalent" DSE and the balance advisable between sheep and cattle for a given DSE. DSE as an estimate of the total carrying capacity of a farm was measured by the number of dry sheep added to around seven times the number of cattle on the farm. A typical example is 5000 sheep plus 400 cattle giving a DSE of 7800.

Using the simulation a series of runs were carried out including cases of :

¼ DSE as sheep and ¾ DSE as cattle,

½ DSE as sheep and ½ DSE as cattle,

¾ DSE as sheep and ¼ DSE as cattle

When total farm activity was taken into account it was found that the mix on the farm was wrong for current and projected forward economic conditions which could affect the farm's operation. Extending the farm with the wrong mix as originally proposed would have actually produced less profit and led to severe financial stress. Over the following years this balance was amended and it was subsequently then practical to increase the DSE by expansion.

An observation of the engineers involved in the project was the profound effect on the owners of discussions on objectives, products, current sales and stock figures and their long term aims as proprietors. They became more aware of the business imperatives and long term planning

needs of their pastoral business. The budget model proved effective in this case when used as a "what if" feasibility study and business educational process.

Some reflections on management by engineers should be recorded as part of this case study. Although items on the profit and loss statement and balance sheet are similar for a farm to that of a manufacturer the accent to be placed on each item is generally different. For example the banks are willing to advance substantial amounts against the real estate represented by the farmer's land which often far outweighs the value of the farming facilities. Manufacturers on the other hand generally have their capital tied up in equipment and working capital which does not attract the same interest from the bank. Often this ability to attract financial support has little to do with the skill or profitability of the venture in both these cases. It should not be interpreted by the farmer as other than the fact that the bank regards a lien on his property as a safe lending basis in the event of the farm's demise.

A point to watch is that farm turnover for a given investment in property is much lower on a farm than that of a manufacturer or most commercial concerns so that ratios such as stock turn, as they apply for example to a retailer operating on a fine margin, are not applicable to the average pastoral property. A further observation is that, in the opinion of the author, some accounting measurements and advisory practices for farms can cause complacency to non-accounting farmers. Stocks are an example. Unlike stocks of iron castings in a factory, increases by breeding on a farm or even freezing of excess produce can lead to a substantial increase in cost increase in stocks if allied sales do not take place. In conventional accounting these increases in stock often lead to a reduction of supply costs in the profit and loss account and correspondingly increase the profit reported. But on a farm with its relatively low turnover there can be a dangerous loss of cash flow and escalation of debt due to the failure to provide sales income through lack of action partly generated by an unqualified apparently buoyant profit report.

Finally it is disappointing to report that despite the success of this project for the farmer concerned, the potential of this process was not appreciated by a senior agricultural scientist who helped organise an animal husbandry conference in Brisbane which we later attended.

We had, as engineers and farmer, provided details and offered to report our findings.[ 51] Yet after a lapse of many years the same scientist who appraised our report was reported by his division as if modeling farm activity had been newly developed by him to advance agricultural management. Apart from questions of plagiarism the problem appears to be that of one profession not being prepared to adjust to the need for cooperation between professions and recognise the contribution each can make to progress by extending the straight jacket of our original professional training. Surely this is one of the lessons from this thesis, that cross fertilisation between skills needs to be expedited and many engineers and technically trained people are no exception to this need.

**Quarry drilling industry case**

A drilling group contracting to quarrying and contracting companies requested use of the simulation model to analyse the potential for taking on an additional agency business offered to them by a major well known supplier of tractor and allied equipment associated with their industry. The products and data on materials required to operate the basic drilling business was entered into the data bank. The products comprised such items as unit length of drilling carried out, drill bits and spare parts. Then the effect of the proposed additional business consisting of parts for heavy excavating equipment and provision of mechanical services was measured. The cost of mechanical parts was dictated by the firm offering the rights to the agency.

In this case the answer was that it would be extremely unwise to enter into this proposed new agreement. It would tie up capital in stocks and consequently cut cash needed to expand the drilling business. In addition the profits would be only marginal and take a long time to become available to augment cash flow. The proprietor was able from this analysis to understand where the project would be damaging to his company even though he had been initially flattered by the fact that a large international group had made the offer to him. He was very appreciative of the simulation's help in clarifying the dilemma he had found himself in. The project again showed the value of simulation as a tool for carrying out a feasibility study.

**Conclusion** These case studies show how a Budget Support simulation can be an effective tool for carrying out feasibility studies involving the financial viability of businesses as diverse as a farm and a quarry drilling company and is therefore strongly recommended for feasibility work.

### 4. 3.3 Budget program applied to the training of University Mechanical and Manufacturing Engineering Students

For 33 years the author has used the budget model principles as a business educational and development procedure for engineering students together with such items as surveys of current management budgeting practice and studies aimed at "quantifying" quality measurement. Some 35 special project and thesis reports have been supervised over this period largely using this approach and often combined with actual industrial practice.

Students had as part of this approach to understand the modeling technique and aim to check or develop some facet of it. A list of these papers is included in appendix B. The students generally responded well to the projects and welcomed the opportunity to participate in a direct application of obvious relevance to their future after the many theoretical but important parts of their logic and technical training. Many of these projects were carried out in conjunction with Research Publications as their management laboratory described in 4.3.1 above. This process of applying the simulation to the management of an actual firm is strongly recommended provided the firm's staff are cooperative and proud of their part in the student training process as they were in this case. It was interesting that the employment prospects of the participants were enhanced by this experience judging by the reception they received later.

Follow on work by students and software programming contracts let by the company led to the development of ancillary programs for pricing and workload planning involving labour and machine allocation and anticipated cost of outside purchases to complete orders in hand. The user friendliness was improved by commissioning a visual basic presentation program

analogous to conventional commercial programs and a comparison program introduced to facilitate management by comparing the budget projections with actual performance achieved.

These developments and allied research set out in appendix A were reported in lectures to the Institution of Engineers, Manufacturing branch and at conferences of the Australian Conference of Management Educators in Sydney, Melbourne and Brisbane. Overseas presentations were made in Jerusalem, Israel to production research people, in Iran at Sheraz, Tehran and Tabriz to mechanical and robotic engineers and at Swansea in Wales where the accent is on European management training. In July this year, a presentation on the Budget Support system was made at a 1999 conference in Honolulu, Hawaii, a conference which emphasised the importance of Fuzzy Logic mathematics and Intelligent Manufacturing Systems. The author attended on behalf of Australia's IMS secretariat at this conference.

As part of this engineering management training activity lecture and seminar notes were developed to assist in the subjects Engineering Economics and Financial Management for manufacturers. [10], [23] and [37]

This training method is recommended for engineering undergraduate training and could be extended as set out in the conclusions of chapter 5, recommendation 6. It should then be incorporated into normal management practice in the field, particularly for engineer managers.

### 4.3.4 Recent development of a Magazine for Societies of the Institution of Engineers Australia.

This case involves a project currently in progress aimed at reducing the parochialism of engineers in the field and preparing them for greater job security and management responsibility. Just as the segmenting of professions such as engineering, accounting, law, commerce and psychology needs to be reduced as technology and economic conditions change, so also do the divisions within the engineering profession need amendment. Currently a situation has developed in which technical societies involving manufacturing, maintenance,

risk, building services and industrial engineers for example are finding it difficult to finance their communications and develop their awareness of skills allied to their own. They need to know of solutions to common problems in management and business their fellow technologists are using.

The growth of bureaucratic control of a professional, essentially technological group, which has delegated its business management to non-technical people can weaken the essential networking needed by engineers in a changing world. If this type of organisation is not careful its administration can become top heavy and pay little attention to the welfare of the members. While members are left with a measure of status the administration can come to regard the other important need, that of member development and assistance, as an unnecessary expense. They need to recognise the importance of allocating member's fees to networking and personal development as well as status and not growth of infrastructure at member's expense.

The result has been that the author and Research Publications decided, now that there is a stronger reception for communication improvement, that it would set up a quarterly publication, "New Engineer Journal" [52]to assist members of financially weak, and networking starved, technical societies with the need emphasised in this thesis. Initially with a Manufacturing Society readership, it is now circulated to a much wider audience. The reception for this action has been encouraging and the financial and editorial requirements are already being met to make the magazine viable after only 18 months as a separate venture. It has of course to develop further. However it is hard to understand why it has been necessary for an independent group of members to have developed this service rather than the Institution itself other than a weakness in management of the type considered in this thesis. The author believes that this is just another example of the weakness of some senior engineers, no doubt brilliant at their technology and design yet untrained in managing and finding it difficult to develop their organisation and meet their member's need to continually update their skills if they are to maintain their positions in industry and commerce. It is recommended that this, now successfully launched, networking journal be consolidated and its membership extended.

# CHAPTER 5
# FINAL CONCLUDING REMARKS & RECOMMENDATIONS

Most practising engineers will have come across some of the business items covered in chapter 2 of this survey and consider them as essential for the management of a particular department of a manufacturing organisation. What the analysis of this thesis, and observations on the literature surrounding the subject shows, is that there are many aspects of business and people skills which engineers need to acquire. Without these they will be relegated to lesser levels of management at a lower standard of living and less status than other professions. These conclusions are drawn from extensive experience and research over the years from observations of Australian manufacturing industries. Professions with a greater grounding in commercial activity and presentation and a more outward image with people will receive opportunities the engineer would not only have been well able to tackle effectively but be more efficient than most executives without a technical background. This of course is obviously the case in a technology based organisation.

Many of the missing pieces of business information described are not difficult for an engineer to understand. Some engineering techniques from the past are now no longer relevant to current needs and often apply to techniques of limited current use. On the other hand it has been explained that early training in how an organisation works and skill and practice in working with and motivating people at many levels is essential for an engineer. The engineers of this era have, of necessity, when working in a market the size of Australia's, to be able to work with people, finance and customers as well as facilities and systems.

A comprehensive process is presented for integrating the activities of an organisation in a way which automatically involves practically all of the additional activities needed by engineers to manage and yet still allows them to apply technical fundamentals. The method requires concentration on overall planning as an integrating process which motivates the engineer and key staff and brings them all into close contact with practically every facet of a manufacturing industry. This method,

the Budget Support system recommended in this work, meets this need by providing long term planning for both shareholders and the staff of a company. The engineer using this tool as a management coordinator can widen his/her horizons and help develop our industries to a standard most other professions are unable to meet since they lack the necessary technical background.

Some more detailed conclusions are highlighted in a sequence to address the following needs:

## (i) THE STATE OF THE ART (EMERGING TECHNOLOGIES)

1. Engineers need to understand business and allied items requiring motivation and control in each department of a firm as outlined earlier. They need to learn also of the part played in industry by other professions such as accountants, lawyers, macro-economists and industrial psychologists and be an equally important part of these activities.

2. Engineers need to recognise that the current era in applied science and computer technology requires an extraordinary rate of change in the relevancy of parts of their own and associated business professions. Computer science and information access has revolutionised many aspects of our activities. It is not always understood by engineers that this applies just as much to professions such as engineering and accounting. This situation, however, frees up the opportunities for engineers to fill the need for more effective management of manufacturing enterprises. To achieve this they have only to cultivate the communication and financial skills required and increase their knowledge of each of the key activities taking place in each department of a manufacturing concern.

## (ii) EFFECTIVE COMMUNICATION

3. Managers need the ability to communicate ideas verbally, in writing and through the media as well as by their own example. Not only is practise required but also the need to concentrate on the other person's needs. This

dictates a necessity to be aware of the background of other people and skill in presenting a proposal.

4. If engineers and their training establishments do not avail themselves of the opportunities to fill the gaps set out in chapter 2 and recommendations suggested in chapter 3, and fail to positively prepare themselves for participation in senior management, it will be to the detriment of our industries and engineers will be brushed aside by other more persuasive, egocentric and generalist professions less able than engineers to contribute to making our industries internationally competitive.

## (iii) PROFESSIONAL DEVELOPMENT IN MANAGERIAL EDUCATION

5. Turning ideas into action through people requires recognition that managers are people developers, not repositories of all the answers, for management to be effective. They need to balance participatory processes with very occasional hierarchical action based on special knowledge. Engineers need to regard their fellow staff as professional partners in a total process. They should grasp every opportunity to express their views and practise communication skills and leadership within their companies and in professional community activities.

6. As the accreditation of university engineering training courses partly depends on the Institution of Engineers Australia's view of what should be included in the courses, it is recommended that the Institution now insist on inclusion of the following specific management subjects throughout each mechanical, industrial and manufacturing engineering course. This would replace the current vague and inadequate stipulation of around 15% management content. One fifth, that is one subject, of each year is considered necessary to progressively develop the initial management skills needed over a four year course.

The recommended inclusions in a four year curriculum are as follows:

Year 1. Concentrate on personal communications, both theory and practice, social responsibility and a knowledge of other professions.

Year 2. Management of facilities, people and services and a knowledge of accounting and business fundamentals. ( Along the lines of the author's work in this respect [37] )

Year 3 Knowledge of the operation of each of the departments set out in chapter 2 of this thesis and the principal criteria involved in managing each.

Year 4 Concentration on management of an organisation using the methods of chapter 4, that is, using hands on simulation of the whole firm, to develop the role of management in the coordination of finance, production, marketing and community needs.

These recommendations will lead to the need for a new look at the balance of practical, industrial and theoretical skill, as distinct from research, in the armoury of those carrying out tertiary training. Post graduate opportunities in industry allowing attendance at a similar series of management training should also be available on a similar accredited basis to that of the undergraduate stage. The status provided by the original qualification of engineering is now not sufficient to maintain a career without attention to continuous ancillary training.

## (iv) COMPUTERISED MODEL FOR BUDGET PLANNING

7. The case studies described in chapter 4.3 have assessed the validity of the model. This has been proven both for progressive master planning of a business 4.3.1, and for analysis of projects to determine their feasibility 4.3.2. In addition this work has been found to be effective in training engineers in the many interacting facets of managing an organisation 4.3.3.

Since engineers are particularly well versed in planning and systems and realise the significance of a proven management information system, it is recommended that during their training accent should be placed on the use of a comprehensive simulation of a business. Later, their management approach could be focused around the budget preparation process as a sound way to tackle top management and board participation. This approach, using the Budget Support system, has been proven as a way of assisting an engineer to embrace the totality of managing an organisation and develop him/her as a manager. This simulation approach is therefore found to be highly appropriate for coordination of an enterprise and encouragement of staff participation in planning and implementation.

The discussions and analyses using the simulation of a company which follow executive meetings to define forward plans provide a ranking of potential for improvements to all aspects of that business. Variables which control future capacity, investment in new processes, products and innovation, research and development, staff training, prices and even attaining market share for example can be given an order of priority. This priority becomes a valuable guide to decision making and the timing of decision implementation.

# CHAPTER 6
# SUGGESTED FUTURE RESEARCH

**Two areas of further research have become apparent as a result of the investigations carried out as part of the research programs involved in this thesis - namely Research and Training.**

**(a) RESEARCH - the Budget Support simulation**

1. Data entry of this program can be extended by including an alternative spread sheet as part of the application. By this means alteration to update a particular company's budget can concentrate on factors peculiar to that company rather than have to reconsider a substantial portion of the data at each time of review as one does when entering data into the simulation for the first time.

2. Models with standard headings applicable to one industry should now be investigated to accelerate commercial acceptance and wider use of the program.

3. The descriptions substantially to the right side of the spread sheet are better inspected, and if necessary updated, using the Key Budget and Help panels and can therefore be largely eliminated.

4. There is clearly a potential for extension of some data entry items to take probability into account and hence develop a predictive capability for the simulation with an accent initially on the range of profitability and cash flow liable to take place. As the model is generic in nature this approach could have a wide application to risk assessment.

5. The software and method of requesting data entry into the separate pricing and production planning programs for small businesses, developed as ancillary programs separate from Budget Support, but based on the standards developed through the simulation should now be streamlined to make them more user friendly.

6. The comparison program which displays actual and budget data could now be augmented by having its "Actuals" entered through a simple interrogation process on the main screen.

7. Investigation of the level of importance of each parameter on financial performance of a manufacturing firm, in particular profit and liquidity, highlight the most significant factors for management in relation to varying economic conditions.

8. An initial small imbalance in assets and liabilities caused by a difference in stock valuation between past company records and the more accurate calculations of the simulation could now be made to automatically reconcile or force correction by management.

**(b) TRAINING - Undergraduate and industrial management training**

1. Design of a promotional program to improve professional acceptance of engineers as industrial leaders so that more engineers are on the board and managing our technology based industries. The targets would include the legal and commercial professions, engineers in education, company directors, shareholders, politicians, the media and the public.
2. Further development of the "New Engineering Journal", the networking and communication periodical recently established to emphasise the importance of management by engineers and improve appreciation of other professional skills. This will assist in reducing parochialism amongst engineers themselves. Engineers need to regard management responsibility as part of their careers, not a responsibility of others.
3. There is the need to translate into lecture, instructional and tutorial format form as well as practical training the education needs of engineers as managers. These have been set out in chapter 3 as general needs and recommended in the conclusions of chapter 5 as specific parts to be included at each level of a tertiary course. The focus needs to change from only learning about a particular item, such as accounts, quality control or operations research, for example. We need to move to equipping engineers to be able to manage any of the marketing, production or

finance departments or the whole company. We should aim at encouraging the Institution of Engineers accreditation group to adopt this approach when examining tertiary training establishments. The problem to be overcome is an entrenched belief in past training as the only way despite radical changes in both economics and technology.

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# CHAPTER 8
# APPENDICES

**A. Refereed International, I.E.Aust and National Publications by the author**

**B. Special project and Thesis Supervision relevant to Budgets and Simulation including associated Books by the author**

**C. Initial accounting equations and a list of Budget Support software symbols used for program descriptions and the data collection process**

**D. Budget Support manual (Inside back cover)**

**E. Budget Support set up disc (Inside back cover)**

# APPENDIX A

## REFEREED INTERNATIONAL, I.E.AUST. AND NATIONAL PUBLICATIONS, TECHNICAL CONTRIBUTIONS AND BOOKS

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# APPENDIX B

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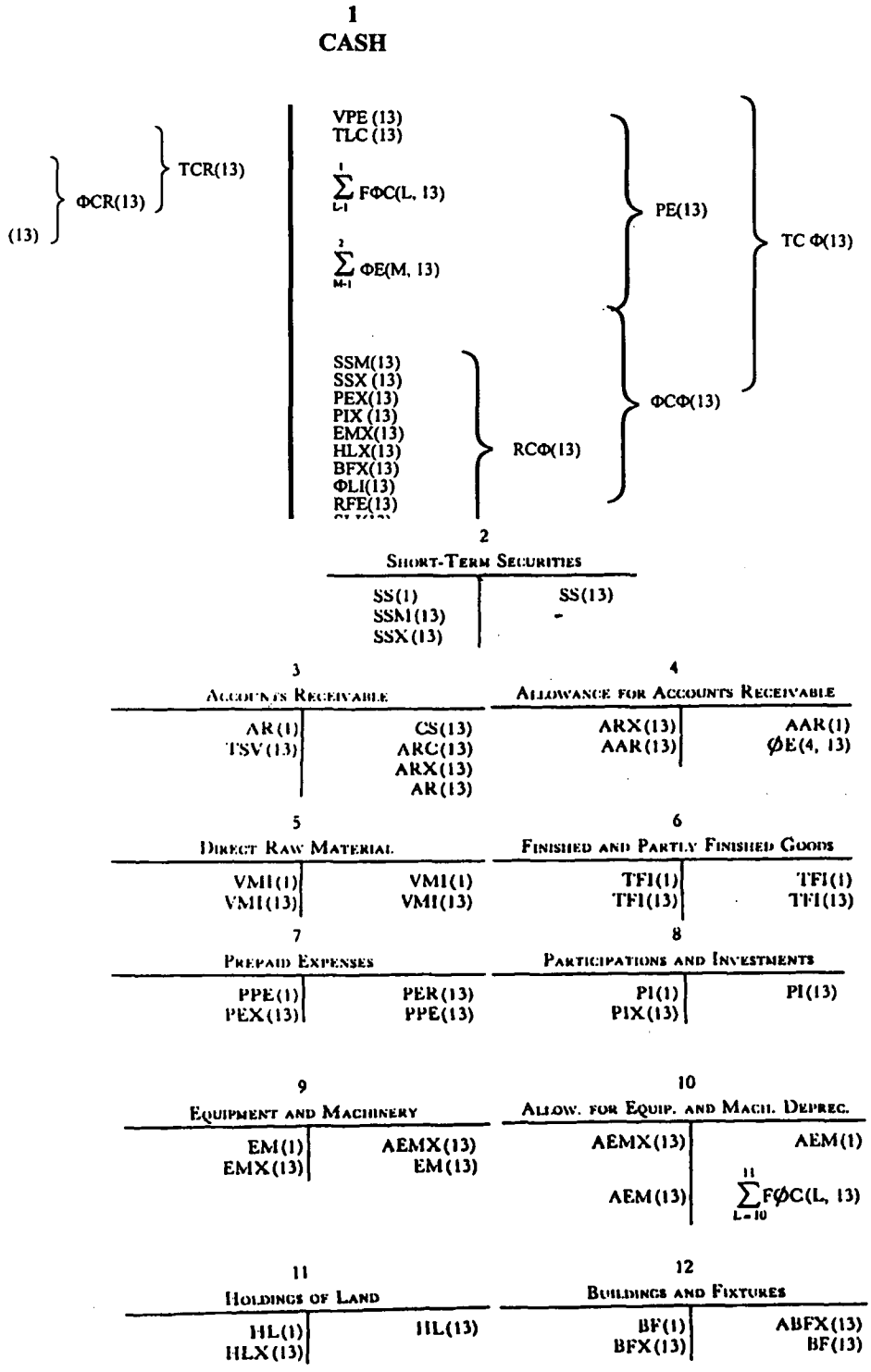
# APPENDIX C

## C1 INITIAL ACCOUNTING EQUATIONS

## C2 SYMBOLS USED IN BUDGET SUPPORT SOFTWARE

# APPENDIX C1 – PART 1




**Basis of equation groups 1 to 12 of the 28 groups which formed the initial accounting framework of the Budget Support program – extracted from Mattessich [46[.**

13

ALLOW. FOR BLDG. AND FIXT. DEPREC.

| | |
|---|---|
| ABFX(13) | ABF(1) |
| ABF(13) | FØC(12, 13) |
| | ØE(5, 13) |

14

VOUCHERS PAYABLE

| | |
|---|---|
| VPE(13) | VP(1) |
| VP(13) | TPV(13) |
| | $\sum_{L=4}^{9}$ FØC(L, 13) |
| | ØE(3, 13) |
| | DD(13) |
| | CT(13) |

15

SHORT-TERM LOANS

| | |
|---|---|
| SL(13) | SL(1) |
| | SLX(13) |

16

ACCRUED EXPENSES

| | |
|---|---|
| AE(13) | AE(1) |
| | AEX(13) |

17

LONG-TERM LIABILITIES

| | |
|---|---|
| TLL(13) | TLL(1) |
| | TLLX(13) |

18

STOCK CAPITAL

| | |
|---|---|
| SC(13) | SC(1) |
| | SCX(13) |

19

PAID-IN SURPLUS

| | |
|---|---|
| PIS(13) | PIS(1) |
| | PISX(13) |

20

RETAINED EARNINGS

| | |
|---|---|
| RE(13) | RE(1) |
| | REX(13) |

21

SALES REVENUES

| | |
|---|---|
| TSV(13) | TSV(13) |

22

COST OF GOODS SOLD

| | |
|---|---|
| VMI(1) | VMI(13) |
| TFI(1) | TFI(13) |
| TPV(13) | CGS(13) |
| TLC(13) | |
| FØ(13) | |

23

DIRECT MATERIAL PURCHASES

| | |
|---|---|
| TPV(13) | TPV(13) |

24

DIRECT LABOR

| | |
|---|---|
| TLC(13) | TLC(13) |

25

FACTORY OVERHEAD COSTS

| | |
|---|---|
| $\sum_{L=1}^{3}$ FØC(L, 13) | FØ(13) |
| $\sum_{L=4}^{9}$ FØC(L, 13) | |
| $\sum_{L=10}^{11}$ FØC(L, 13) | |
| FØC (12, 13) | |

26

OPERATING EXPENSES

| | |
|---|---|
| $\sum_{M=1}^{2}$ ØE(M, 13) | TØE(13) |
| ØE(3, 13) | |
| ØE(4, 13) | |
| ØE(5, 13) | |

27

FINANCIAL AND MISC. EXP. AND REV.

| | |
|---|---|
| ØLI(13) | CRI(13) |
| RFE(13) | RFR (13) |
| SLI(13) | FME (13) |
| AEX(13) | |
| PER(13) | |

28

PROFIT AND LOSS

| | |
|---|---|
| CGS(13) | TSV(13) |
| TØE(13) | |
| FME(13) | |
| DD(13) | |
| CT(13) | |
| REX(13) | |

**Basis of equation groups 13 to 28 of 28 groups which formed the initial accounting framework of the Budget Support program – extracted from Mattessich [46].**

# APPENDIX C – PART 2

## A LIST OF PROGRAM SOFTWARE SYMBOLS USED FOR PROGRAM DESCRIPTIONS AND THE DATA COLLECTION PROCESS.

Note: * These are additional symbols which are incorporated into the equations of figures 34A and 34B.

| SYMBOL | DESCRIPTION |
|---|---|
| AAR | Allowance for accounts receivable |
| ABF | Allowance for buildings and fixtures |
| ABFX | Allowance for buildings and fixtures, special changes |
| AC1 | Accounts receivable collection coefficient for sales last June |
| AC2 | Accounts receivable collection coefficient for sales last May |
| AC3 | Accounts receivable collection coefficient for sales last April |
| AE | Accrued expenses |
| AEM | Allowance for equipment & machinery - depreciation |
| AEMX | Allowance for equipment - depreciation changes |
| AEX | Accrued expenses changes |
| AGFLAG | Control defining type of report |
| APQ | Adjusted production quantity in units |
| AR | Accounts receivable |
| ARC | Accounts receivable collections* |
| ARX | Accounts receivable special changes* |
| BCGS | Budgeted cost of goods sold |
| BE | Ending product unit stock |
| BF | Buildings and fixtures |
| BONUSES | Bonuses or wage payment adjustments |
| BFX | Building and fixtures monthly changes |
| BI | Beginning inventory in units of work in process and finished stocks |
| BPOC | Desired profit as a fraction of cost |
| CASMAX | Cash maximum level before short term investment |
| CASMIN | Cash minimum level before drawing on reserves |
| CGS | Cost of goods sold* |
| CHB | Cash on hand and in the bank at beginning of month |
| CRI | Cash receipts of interest on long term securities* |
| CS | Cash sales* |
| CSC | Cash sales coefficient |
| CT | Corporation taxes* |
| DD | Dividend to be declared |
| EI | Ending inventory of finished and partly finished goods in units |
| EM | Equipment and machinery |
| EMX | Changes in equipment and machinery during the year |
| FFR | Fixed factory overhead rate |
| FME | Financial and miscellaneous expenses (net)* |
| FO | Factory overheads* |
| FOC | All factory overhead costs* |
| F0CJ | Factory overhead costs one month pre budget |
| F0CM | Factory overhead costs two months pre budget |
| F0E | Fixed administration expenses |
| FPC | Factory overheads payment coefficient |

**A list of program software symbols used for program descriptions and the data collection process of the Budget Support program.**

| | |
|---|---|
| FPF | Fixed part of factory overheads |
| HL | Land value |
| HLX | Changes in land values during the year |
| I | A product or sub-assembly |
| IDUMMY | Spare code for a control |
| IES | Code defining wage calculation method |
| JJ | Number of material categories |
| KK | Total number of labour, including sales labour, departments |
| KP | Number of direct labour departments |
| KS | Number of service labour departments |
| LL | Number of overhead departments |
| L1 etc | Overhead departments |
| MATL$ | Materials |
| MM | Number of administrative departments |
| M1 etc | Administrative departments |
| MON$ | Periods - including a summary period |
| N | Number of products or sub-assemblies |
| NI | Product No. of a product which changes material content |
| NJ | Material No. of a material subject to content change ratio for a product |
| NCOST$ | Factory overhead departments |
| NDEPT$ | Direct wage departments |
| NEX$ | Administration departments |
| NOC | Identification number of a company |
| NP | Code for service department proration |
| NPROD$ | Products |
| NSPT | Code defining sales price changes when volume of sales applies |
| OCO | Other cash outlays* |
| OCR | Other cash receipts* |
| OE | Administrative expenses* |
| OIR | Ordinary long term liabilities interest monthly rate |
| OLI | Long term liabilities interest rate* |
| PC | Production cost |
| PCG | Fractional drop in materials ratio which applies after a particular production quantity is reached |
| PE | Payroll expenditure* |
| PQC | Production quantity at which a new materials ratio could apply |
| PER | Prepaid expense reversal |
| PEX | Prepaid expense charges |
| PI | Participations and investments |
| PIX | Changes in participations |
| PIS | Paid in surplus |
| PISX | Changes in paid in surplus |
| PK | Production coefficient |
| PKN | New production coefficient |
| PMC | Purchases monthly coefficient |
| PMI | Product minimum units of inventory |
| PMK | Purchases of material coefficient |
| PPE | Prepaid expenses |
| PQ | Production quantity in units |
| PRMJ | Purchases of raw materials in the pre budget month |
| PROMOT | Additional promotion to the normal budget |
| PSQ | Previous sales quantity units |
| PUC | Product unit cost |

**A list of program software symbols (continued) used for program descriptions and the data collection process of the Budget Support program.**

| | |
|---|---|
| PUCO | Opening product unit cost |
| RCO | Remaining cash outlays* |
| RCR | Remaining cash outlays* |
| RE | Retained earnings |
| REX | Remaining financial expense changes* |
| RFE | Remaining financial expenses |
| RFR | Remaining financial receipts |
| RMI | Raw materials inventory |
| RMMI | Raw materials minimum inventory |
| RMR | Raw material requirement in units |
| SC | Share capital |
| SCX | Share capital changes |
| SI | Sales Index |
| SIR | Short term securities monthly interest rate |
| SK | Sales distribution coefficient |
| SL | Short term loans |
| SLC | Standard hourly labour cost |
| SLH | Standard labour hours |
| SLI | Short term loans interest expense* |
| SNAMES$ | Vertical titles for product cost budget |
| SLR | Short term loans monthly interest rate |
| SLX | Short term loans change during year |
| SMATRX | Overheads distribution for each product for product costs |
| SP | Sales prices |
| SQ | Sales quantity in units |
| SS | Short term securities |
| SSM | Short term securities adjustments |
| SSX | Changes in short term securities by preplanning |
| SUBCONTS | Refers to the list of alternatives in the sales wages adjustment file which allows some sales wages applicable to sub-contracting to be added to direct wages for the hourly rate calculation |
| SV | Sales volume |
| TCO | Total cash outlays* |
| TFI | Total finished goods inventory* |
| TLC | Total labour cost* |
| TMI | Total materials inventory* |
| TOE | Total administrative expenses* |
| TLL | Total long term liabilities |
| TLLX | Total long term liabilities changes |
| TMR | Total material requirement in units |
| TPC | Total product cost |
| TPV | Total materials purchases* |
| TSV | Total sales volume |
| TSVJ | Total sales 1 month pre budget period |
| TSVM | Total sales 2 months pre budget period |
| TSVA | Total sales 3 months pre budget period |
| UCM | Cost of materials per unit |
| UCMO | Cost of materials in beginning inventory per unit |
| VFR | Variable overhead rate |
| VMI | Direct materials inventory* |
| VP | Trading accounts payable |
| VPE | Accounts payable expenditures* |

**A list of program software symbols (continued) used for program descriptions and the data collection process of the Budget Support system..**