receptivity to training is improved and the need for skilled workers can be met through adequate training and motivation programmes (Chapter 6).

The eighth problem, **lack of appropriate supervision**, is diminished somewhat by JIT because through the use of simple techniques (Chapter 7), workers assume much of the burden for trouble-shooting and analysing problems. TQC reduces the need for supervision over quality matters, since workers inspect their own quality.

Informal and casual quality control, ninth in the list, is a problem in small fast-growing companies where the typical solution is to add a QC department. JIT, however, opts for a more natural approach which is to keep the responsibility for quality in the production department and to train the workers and foremen in quality measurement and analysis (Chapter 6; Chapter 7).

The tenth and final problem is that of **low productivity**. JIT/TQC increases productivity by averting scrap, rework, and customer returns arising from poor quality, as well as better utilising resources and materials. Several of the techniques for achieving this are described throughout this report.

3.2.4.2 Transference of Technology

Since technology is transferable, and since the Japanese have demonstrated great industrial success in recent years, attempts have been made to transfer Japanese technology such as JIT and TQC to other countries. By following a set programme for improving quality, such as described in this report, it is felt that this transference of technologies will be greatly aided, and their eventual operations enhanced.

Developing countries desperately need to improve the quality and productivity of their goods to survive. The quality improvement programme, together with the techniques of JIT and TQC are appropriate tools to help manufacturing companies achieve this since they are simple, resource conserving and complementary.

3.3 CONCLUSION

The need for quality is well understood by everyone. The method of achieving it, however, is generally not well known. In this chapter, several quality improvement programmes have been investigated. It was found that although each programme had a similar basic structure, they did differ from one another. The question arises as to which programme is the right one to follow. The answer to this is that there is no 'right' programme. Each programme has some benefit to offer and each may perform better than another under different circumstances.

The purpose of this chapter has been to analyse each programme and to construct a new programme for improvement, based on the already existing programmes. In this way all the benefits that each of the programmes have to offer can be incorporated into one plan. This proposed plan forms the basis of this report and a description of each of the steps of the plan is dealt with in the following chapters.

4.0 MANAGEMENT COMMITMENT

4.1 INTRODUCTION

When considering management commitment in the light of a quality improvement programme, it must be understood that top-management commitment means a great deal more than a chief executive giving his or her blessing to the programme. The key to commitment is not even in providing the necessary funding for the effort. It is first and foremost to recognise that the quality improvement effort will require active leadership from top management rather than passive support (Ishikawa, 1985).

This chapter identifies the need for management commitment as well as to describe techniques for obtaining it. The technique used is the quality costing method of uncovering the true cost of non-conformance. Also included in this chapter is a list of the appropriate actions that must be taken by management, once they have committed themselves to quality improvement.

4.2 QUALITY RESPONSIBILITY

Many companies recognise when they need to change from inspection-oriented product acceptance systems to professionally planned quality programmes. The recognition may come slowly, but it becomes an inexorable conclusion when business and customers are lost because of poor quality or when failure costs skyrocket. At this stage, top management may understand it is in trouble, but not know how to handle it or what kinds of changes it should institute (Smith,1979).

In almost every case, the answer is to go outside the company and look for a quality professional who can turn quality around, restore the company's quality image, and reduce its quality costs (Smith;1979).

In general this is a good beginning step for companies just awakening to the fact that they have severe quality problems. Smith (1979), however, feels that problems intensify rather than abate once the new quality person appears. Simply because at this stage, top management sigh with relief and then forget about their quality problems, confident of the fact that they have hired quality professionals to deal with matters.

However this is not the case since quality professionals can only:

- establish the systems,
- put in and monitor the controls,
- train and develop people to the new quality methods,
- change attitudes,

but they cannot do the jobs of designing, manufacturing, and servicing the product. Those are rightfully the jobs of engineering, manufacturing, and marketing, and the quality aspects of those jobs are their responsibility as well.

Quality is the responsibility of general management, not of the quality professionals. And unless that very basic and necessary rule is understood and practiced, quality will never happen.

The new quality professionals cannot and do not solve all the quality related problems. These can only be solved from within, by following a comprehensive quality programme. From a broad, conceptual point of view, there are two primary ingredients in the successful execution of a quality programme. First, get the right top management support and commitment, and second, do the right things to improve quality.

When top management refuses to face up to its responsibilities to obtain quality, no quality programme will be able to solve their problems. That is to say that top management must be involved 100%.

4.3 COST OF QUALITY

Having stressed the importance of management commitment, it is now necessary to identify the methods used to obtain it.

In most companies it can be found that two universal languages are spoken (Figure 5 on page 46). At the 'bottom' end, the language is that of things and deeds: square meters of floor space, schedules of 400 tons per week, rejection rates of 3.6 percent. For top management the language is that of money: sales, profits, taxes, investments. Top executives love to order cost cuttings, considering it the ultimate purpose of management (Schonberger, 1982).

According to quality consultant Colin Bloom, one of the biggest problems facing a company today is the lack of communication between top and middle management. This problem has developed since middle management has not learnt to talk to top management in terms of money. Traditionally the quality control function has been responsible for reporting quality performance to management in terms of rejection and defective material reports. This vital information is often difficult to analyse and interpret in terms of costs. As a result, cost saving opportunities are often overlooked. Successful business requires financial planning and control. It is therefore advisable that quality failures be presented in financial terms (British Standards Institution, 1981). The device that allows this to be accomplished is the Cost of Quality, which essentially measures the the cost of doing things wrong.

4.3.1 QUALITY COST CATEGORIES

While there are many systems for identifying quality costs, the following is a widely applicable breakdown into four categories (Juran and Gryna,1980)(BSI,1981). Examination of these categories will reveal that they are all costs associated either directly or indirectly with making defective products. Quality costs is therefore an unsatisfactory name for these categories since the costs included in the definitions are not the positive costs of achieving superior quality, but rather the negative

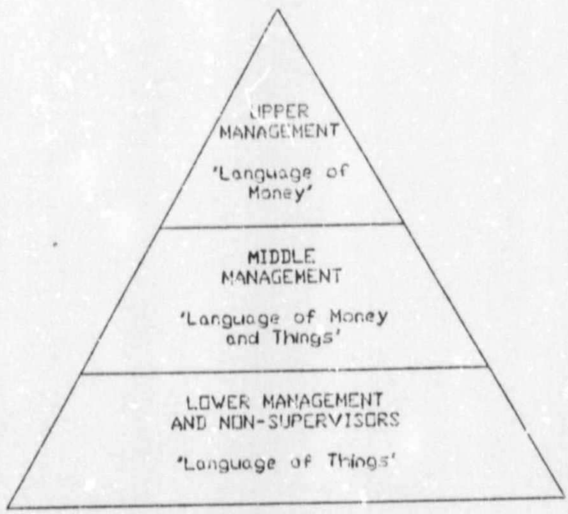

Figure 5. Company Language

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costs of doing things incorrectly. They are thus 'unquality' costs (Groocock;1986). However, the name 'quality cost' is so ubiquitous that it is not practicable to change it. It is however important to remember what it really means and not be misled by the apparent meaning.

- <u>Internal Failure Costs</u>-The cost arising within the manufacturing organisation of the failure to achieve quality specified. These are the costs which would disappear if no defects existed in the product prior to the transfer of ownership to the customer. These include: scrap,rework, downtime, reinspection and downgrading.
- <u>External Failure Costs</u>-The costs arising outside the manufacturing organisation of failure to achieve quality specified. They are distinguished from the internal failure costs by the fact that the defects are found after the transfer of ownership to the customer. These

include: complaints, returned material repair, warranty costs, product liability and cost of recall.

- Appraisal Costs-The cost of assessing the quality achieved. These are the costs incurred to discover the condition of the product, mainly due the 'first time through'. These include: incoming material inspection, inspection and test, maintaining accuracy of test equipment, material and services consumed, and evaluation of stocks.
- Prevention Costs-The cost of any action taken to investigate, prevent or reduce defects and failures. These costs are incurred to keep failure and appraisal costs to a minimum. These include: quality planning, training, process control, design review, quality reporting, supplier assurance, and improvement projects.

Initially, two important facts should be appreciated. Firstly, failure costs, however caused, reduce profits and secondly, preventive quality control activities and the appraisal of quality standards cost money to operate. However it must be understood that investment in prevention and appraisal can substantially reduce internal and external failure costs Furthermore reductions in external complaints are important not only to reduce costs but to maintain customer goodwill. Figure 6 on page 48 (Lester;1977) shows how by increasing expenditure on preventive and appraisal costs, the cost of failure may be expected to fall.
Thus the overall decrease in costs constitutes net profit generated. However there is a point at which total costs will be at their lowest. Figure 7 on page 49 indicates this clearly.

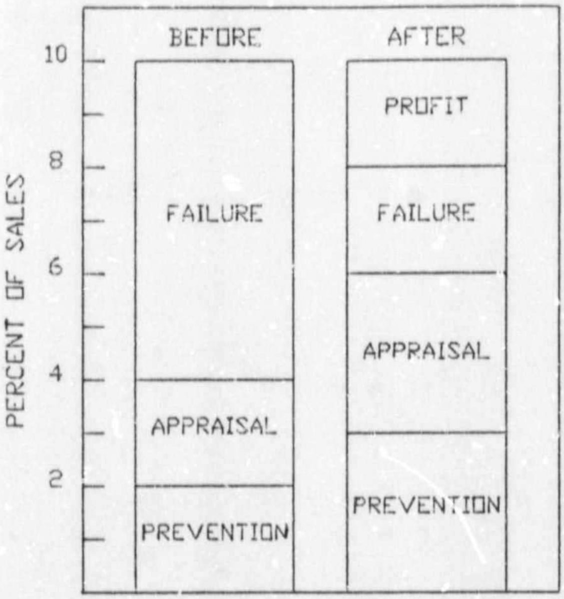

Figure 6 Costs Before and After Effective Quality Control

4.3.2 ZERO DEFECTS (ZD) BUDGET

In many instances most quality cost categories are not reflected in the charts of accounts of the prevailing cost accounting systems. Hence the accountants are unable to provide figures on what are the costs incurred with respect to such categories. What the accountants can provide readily are figures for those quality cost categories which coincide with accounts that are elements of departmental budgets. However, the first efforts to secure quality cost figures typically disclose that the bulk of the categories cannot be evaluated from the accounts regularly maintained by the cost accountants (Juran and Gryna, 1980). Moreover, when quality costs are viewed separately, each may be so small as to be unable to compete for managerial priority. The most significant figure in a quality cost

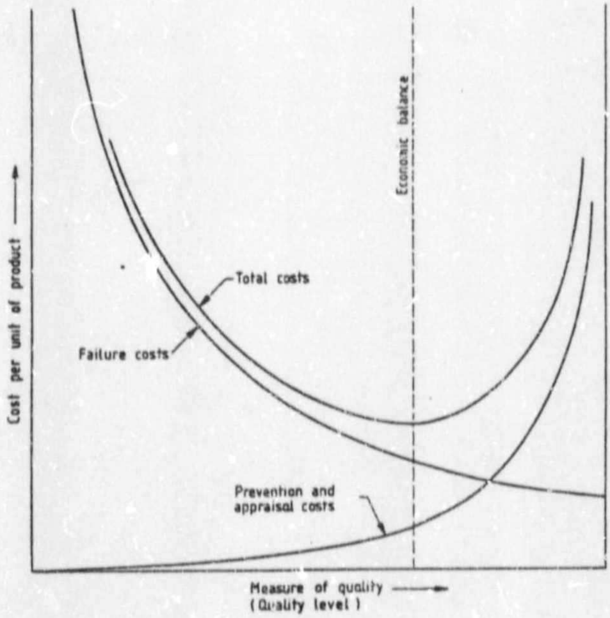

Figure 7. Quality Cost Model

study is the overall quality cost total and when separate quality costs are combined to give a grand total, managers are usually stunned by the size of the total, since they invariably do not realise the amount is so large. In some cases this amount can be as much as 15 - 20% of sales (Crosby P.B., 1980).

According to quality consultant Colin Bloom, one technique which is used to overcome the above mentioned problems is the Zero Defects (ZD) Budget. The ZD budget is a method of isolating the complete price of non-conformance, using data that is readily available in all companies. It must be noted that price of non-conformance is the true definition of quality costs.

The ZD budget can be explained in terms of the following equations:

BUSINESS EXPENSES = PONC + POC + PROFIT

ZERO DEFECTS = POC + PROFIT

PONC = BUSINESS EXPENSE - ZERO DEFECTS

where PONC : Price of Non-conformance

POC : Price of Conformance

In all companies the data that is readily available is:

- BUSINESS EXPENSES : value of sales.
- POC : the cost of manufacturing, without problems, including labour, materials, machinery.
- PROFIT : the difference between manufacturing costs and sales figure.

Thus the total loss due to non-conformance can be determined. Note, this method can only yield a good 'guesstimate'.

The ZD budget is best illustrated by the example which has been drawn up for the manufacture of professional printed circuit boards at the company MSN Products. This example can be found in Appendix 1. For the purpose of concealing confidential information, certain data supplied by the company, has been altered.

4.3.3 PRESENTATION TO MANAGEMENT

Presentation to management should be done in a way such that what remains to be discussed is the merits of the proposals, not the validity of the data. Nevertheless, many presentations of quality cost data have resulted only in a debate on the validity of the figures. Juran and Gryna (1980) has listed the challenges to the data as having mainly been due to:

- Inclusion of non-quality costs. Care must be taken with ambiguous words like 'waste'. Material which is so defective as to be unsalvageable is sometimes called 'waste'. This word is also used when referring to scrap, turnings and off-cuts. If the value of such material is included in the quality cost figures, any challenges to the presentation will be quite in order, since such categories of waste are unrelated to quality and hence are not quality costs.
- Implications of reducing quality costs to zero. Care must be taken when presenting a proposal which suggests a zero defects plan with no quality costs. Practicing managers are quite sensitive on this point and are quick to challenge any presentation which even remotely implies that it is feasible to reduce the quality costs to zero, since before this stage is reached, the incremental control and prevention efforts rise more rapidly than the resulting cost reductions.
- Reducing quality costs but increasing total company costs. In proposing reductions in quality costs, care must be taken to avoid disproportionate increases in other costs. It becomes necessary to quantify the effects of all associated variables of the plan in order to assure that the reduction in quality costs would not result in an increase in total costs.

- <u>Understatement of quality costs.</u> Within any presentation, the argument will be raised that the present status quo is 'usual', 'standard', 'regular', etc. It is for this reason that the presentation must not be centred around criticising the company's variances from present standards, but should in fact challenge the standard levels themselves.

4.4 MANAGEMENT ACTION

Having been alerted to the need for quality improvement, it is important to ensure that the necessary actions are taken by management to ensure success. Firstly it is seen that top management must assume leadership in bringing about a breakthrough. Top managers must establish clear-cut goals and guidelines that deal with the issues of the company. Top management must determine the positions the company will take in regard to quality. It must establish policies in regard to the general attitude surrounding it. Policies thus established, must be disseminated throughout the entire organisation and implemented by all workers, from top management down to line workers. These policies must deal with the rationalisation of management, the revitalisation of the company, and the desire to manufacture products with the highest quality (Ishikawa, 1985).

Just issuing policies however, does not do anything for the company. Top management must be in the forefront of activities and assume the leadership position so as to check what has been accomplished, and provide further guidance. To ensure this, a system must be organised where by the necessary information concerning quality can be fed back to the top management on a regular basis (Ishikawa, 1985).

Finally top management must establish long-range plans for present products as well as for the development of new products. In performing this task adequately, targeted quality standards and design quality standards become an important concern.

4.5 CONCLUSION

In this chapter we have identified the need for management. Simply supporting an improvement programme or being involved in its development is not enough for high level managers, they must be committed to its success. Part of this commitment is recognising that the improvement programme will require the use of some of the key people in the organisation. These people have to be identified, they have to be freed from some of their responsibilities, they have to be moulded into an effective team, and they have to have the authority and responsibility to do the job (Crosby, 1980).

These together with other issues, involved in quality improvement teams, are dealt with in the next chapter.

5.0 QUALITY IMPROVEMENT TEAM

5.1 INTRODUCTION

The problems contributing most to the costs of poor quality will almost always be those that are long lasting and require input from different departments for their solution. The causes of such problems are almost never the result of shortcomings in one department alone (Hutchinson, 1985).

It is therefore necessary to set up a team of managers and specialists, representing a range of appropriate skills and knowledge, to be formed to tackle the problem. The members of the team should be selected from different departments so that the team can cut across organisational boundaries and work with every department.

The purpose of the team is to provide direction and advice on the improvement programme as well as to provide the necessary resources in the form of critical resource persons and funding. Further use of the team can be made to reconcile department needs with competing needs in the company (Crosby,1980).

5.2 STRUCTURE OF THE TEAM

The quality improvement team should be made up of a group of about five to eight people coming from different functional areas. A group that is made up of fewer than four members will fail to bring the necessary talent to the project and to capitalise on the educational benefits of participation (Crosby, 1980).

The primary tasks of the group is:

- to define the detailed set of procedures needed to reach the desired objectives,
- ordering the priorities,
- ensuring that each project attempted remains congruent with the overall project's efforts and,
- to act as a conduit to and from their respective functional areas and user-groups.

5.2.1 GROUP LEADER

The quality improvement team should strictly be a part-time job for the members with the exception of the chairperson or group leader, who should become deeply involved. Therefore, the selection of the group leader is an important step. The requirements of the group leader are: (Crosby, 1980)

1. The leader should b[illegible] [illegible]ature member of management who understands the need to improve [illegible] with the concept of a quality improvement programme.
2. The general manager and the manager's staff must have confidence in the person chosen.

No special skills are involved. The leader's role is to see that the project stays on schedule, to resolve differences among the members of the team and to ensure that resources are provided as needed for the project but at the same time ensuring that spending is within budget.

5.2.2 GROUP MEMBERS

When selecting members for the quality improvement team, it is important to select members from different departments. Ideally each department should have a representative on the team, although in practice this is not practical as the number of different departments in a typical manufacturing company can be as much as twelve.

According to Schonberger (1985), it is common to look at organisations as having three basic functions that must be managed.
Figure 8 on page 57 shows these to be money, demand, and operations. These are said to be line functions. These departments may be known as finance, marketing, and production. Other departments that provide advice and support for the line departments are known as the staff departments. Typical staff departments are personnel, quality control,

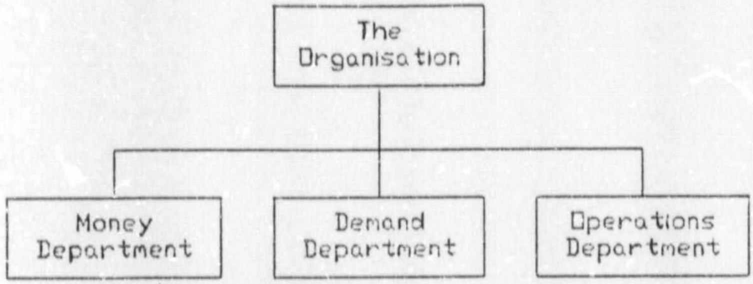

Figure 8. Basic or Generic (Line) Departments

engineering, purchasing, production control, and information systems. The team can comprise of nine members, each selected from the various departments.

The selection of the leader within this group should be done by vote. In this way each member can, in turn, explain their qualifications and the final choice will be based on experience, group confidence and popularity, all of which are important attributes for a leader.

5.3 BENEFITS OF A TEAM

There are several benefits that can be identified of forming a team to administrate a quality improvement programme: (Juran and Gryna, 1980)

- Each member of the group and other managers all have loyalties to their own departments, and thus they may not be completely objective in conducting analyses and drawing conclusions. The team will ensure objectivity of analysis.
- Investigation of problems often requires technical skills that line managers do not posses. The team can provide this skill.
- Large problems require investigation time that line managers simply do not have. The team can provide the resources and manpower to assist the managers.
- Part of an investigation involves conducting experiments and/or collecting existing data. If the improvement team includes managers of those departments where the experiments are to be conducted, this will expedite the investigation.
- If the managers, affected by the solutions to be problems, have been members of the quality team, it will be more likely that they will agree with the solution and use it.

5.4 OBJECTIVES OF THE TEAM

Although the team has the responsibility of creating and directing the programme, it cannot achieve this without a clear set of objectives to work by. These objectives should include: (Crosby, 1980)

- Defining and agreeing on the specific aims of the improvement programme.

- Contributing ideas for the implementation of the improvement activity.
- Generating ideas on possible causes of the problems as well as providing information and advice on overcoming the 'resistance to change' inherent in proposing new approaches.
- Each member representing their department on the team.
- Each member representing the team to their department.
- Causing the decision of the team to be executed in each member's department.
- Laying out the entire quality improvement programme.

5.5 CONCLUSION

Since every function of an operation is a contributor to defect levels, every portion must participate in the quality improvement effort. It is for this reason that it is important to establish a quality improvement team, made up of representatives from every department.

The establishment of this team and the organisation of the improvement programme does not represent an additional expense for the operation. It is really pulling together and organising things that are happening in one form or another at the present time. By formalising it and centralising the effort, it is possible to eliminate duplication of effort.

Having formed a team to administrate the quality improvement programme, it then becomes important to ensure that the employees are aware of the team and its efforts, and that they don't resist the changes proposed by the team. This can be achieved through training and education and will be dealt with in the following chapter.

6.0 EMPLOYEE TRAINING AND EDUCATION

6.1 INTRODUCTION

Human beings evidently possess an instinctive urge to attain quality - to make good products rather than bad. Outside of the workplace this instinct is widely evident, for example, in the projects of children or in the hobbies of adults. Within the workplace this instinct can face strong competition from other parameters. The enterprise needs high productivity, low costs, prompt delivery, etc., as well as good quality. The industrial manager would like to meet all these parameters. But this ideal is hard to attain in an economy based on competition in the market place. Hence the manager resorts to 'trade-offs'. These trade-offs can push quality down or up depending on the state of the economic cycle, the actions of competitors, etc. (Juran and Gryna, 1980).

This competition among parameters extends to all departments and all levels of the hierarchy, including the non-supervisors. Workers are also asked to meet multiple standards, that is, productivity, quality, safety, etc. As in the case of the managers, all workers are for quality. But workers, like managers, find it difficult to meet all standards simultaneously, and hence must resort to trade-offs so as to strike a balance. These trade-offs more often than not result in a decrease in product quality and an increase in defects (Juran and Gryna, 1980).

This chapter deals with operator-controllable defects, the subspecies of these defects, the identification and cause of these defects, as well as the methods used to eliminate them.

6.2 IDENTIFYING OPERATOR ERRORS

In theory, a worker in a state of self-control has no reason to make errors. Yet in practice all human beings make errors to such an extent that human fallibility has long been taken for granted - 'to err is human'. In trying to solve the practical problem of worker errors, the line of action that many companies take is that of motivation programmes. This is based on the theoretical assumption that if workers are properly motivated they will make no errors. Although motivation does play a part in reducing errors, according to Juran and Gryna (1980), the fatal assumptions of these motivation programmes are:

1. operator errors are the main source of quality troubles, and
2. all operator errors can be remedied by proper motivation.

In reality what the facts show are that (Juran and Gryna, 1980):

1. The bulk of defects (over 80%) are management-controllable, not operator-controllable.
2. There are multiple subspecies of operator-controllable errors; the matter is not as simplistic as motivation alone.

6.2.1 SUBSPECIES OF OPERATOR ERRORS

There are at least three subspecies of operator errors (Juran and Gryna, 1980):

1. Inadvertent errors.
2. Technique errors.
3. Wilful errors.

Each of the three subspecies of operator errors has its own set of outward symptoms.

6.2.1.1 Inadvertent Errors

Inadvertent errors exhibit several distinguishing features. They are typically:

- **Unintentional.** The operator does not want to make errors.
- **Unwitting.** At the time of making an error the operator has no knowledge of having made an error.
- **Unpredictable.** No one knows beforehand just when the worker will make an error, or what type of error will be made.

Among the various subspecies of the operator errors, only the inadvertent errors exhibit randomness. In consequence, when data on an operator error does exhibit randomness, it is highly probable that the errors are of the inadvertent type.

The solution for inadvertent errors involve three major approaches:

1. Reducing the extent of dependence on human attention. The methods used are usually termed 'foolproofing'. The idea of making the process somewhat foolproof has become basic in Japanese TQC and is referred to as 'Bakayoke'(Bicheno, 1986; Schonberger, 1982).
2. Making it easier for human beings to remain attentive. This approach employs psychological tools (job rotation, rest periods, etc.) as well as technological tools (templates, masks, overlays, etc.) (Grandjean, 1982).
3. Motivating the worker. (This is discussed later in the report).

6.2.1.2 Technique Errors

Technique errors arise because the worker lacks some essential technique (or skill, knowledge, etc.) which is need to avoid making the error. The features of technique errors are:

- **Unintentional.** The operator does not want to make errors.
- **Consistent.** The operator who lacks technique will consistently make errors of that type.
- **Witting or unwitting.** Technique errors are of both kinds.

The outward evidence of technique errors is the presence of consistent differences in error rates among workers. These consistent differences are selective - they apply to specific defect types.

The options available to solve the technique error are:

1. Train the inferior performer to acquire the missing skill.
2. Change the technology so that the process itself embodies the missing skill.
3. Foolproof the operation in ways that require use of the missing skill.

6.2.1.3 Wilful Errors

Wilful errors are those which workers know they are making and which they (usually intend to keep on making. The features of wilful errors are:

- **Witting.** At the time the error is made, the worker knows that an error has been made.
- **Intentional.** The worker deliberately commits an error.
- **Consistent.** The workers who cause wilful errors usually do so on a continuing basis.

Wilful errors exhibit a pattern of consistency and are not random. Wilful errors might be related to worker trade-offs which result in wilful violations of the quality standards in order to meet other standards which seem to have managerial priority. Real or fancied grievances, against the company or the boss, might be the other reason for wilful errors, resulting in workers taking their revenge by neglecting quality.

Remedies for wilful errors are:

1. Improve communications between managers and workers.
2. Make each operator accountable for his work.
3. Foolproof the operation to ensure that wilful errors cannot be made.
4. In extreme cases the offender must be removed.
5. Motivate the worker.

6.2.2 ANALYSIS OF PERFORMANCE PROBLEMS

Operator problems come in many guises, each of which is solved by a different solution. To ensure that a problem is successfully solved a methodical method for identifying it is needed. In their book, 'Analysing Performance Problems' (1970), R.F. Mager and P.Pipe describe a procedure for analysing and identifying the nature and cause of performance problems. This procedure is summarised in Figure 9 on page 67

Within any working environment there exists performance discrepancies. This is the discrepancy between someone's **actual** performance and their **desired** performance. The first step of Mager and Pipe's procedure is to identify the nature of the discrepancy and having identified the nature, its importance must be considered. If, when considering the importance of the discrepancy, it is found that it is not important, and resolving

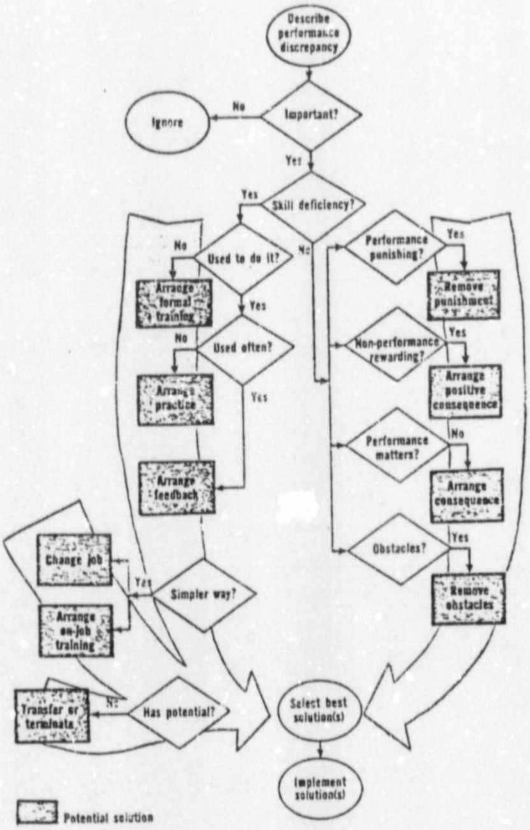

Figure 9. Flow Chart Illustrating Performance Problem Analysis

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the discrepancy will have very little worthwhile result, the discrepancy should simply be ignored. On the other hand if it is found to be important, the next step is to determine its cause. The next step is a pivotal point in the procedure, because the outcome of this step determines which of two sequences of actions must be followed. In this step it must be decided whether the performance discrepancy is due to a skill deficiency. In essence, is the operator not performing as desired because he does not know how to do it? If there is a genuine skill deficiency, then the primary remedy must either change his skill level by teaching him how to do it, or change what is required of him. If, on the other hand, he is able to perform but doesn't, the solution lies in something other than in enhancing his skills. 'Teaching' someone to do what he already knows how to do isn't going to change his skill level. The remedy in this case is to change the conditions under which he is expected to do that which he already knows how to do.

6.2.2.1 Skill Deficiency

When faced with a genuine skill deficiency, there are several steps that must be taken before formal training should be administered. The first of these is to determine if the operator ever had the skill that is lacking. In the case when he never had the required skill, a formal training programme, to teach him the skill, must be arranged. If, on the other hand, he once possessed the skill, it is important to determine whether the lost or deteriorated skill is used frequently or infrequently.

If the skill is used frequently but has deteriorated despite regular use, performance levels may be maintained by providing periodic feedback. If the skill is used infrequently, performance levels may be maintained by arranging a regular schedule of practice.

This now provides three tentative solutions, but there are still two more questions to ask about each situation before the problem can be clearly defined:

1. Is there a simpler way to do the job?

   Even when a genuine skill deficiency exists, any solution to the problem should be weighed against the possibility of changing the job, and if training seems to be the only remedy, on-the-job training may be easier and cheaper, and just as good as the formal variety (Mager and Pipe, 1970).

2. Does the operator have the potential to benefit from this solution? When considering changing a job to better suit an operator, further consideration must be taken as to whether the operator has what it takes to do the job, either mentally or physically, otherwise the changes could be a waste of time. If the operator doesn't have the potential to do the job, the only alternative left would be to transfer him.

6.2.2.2 No Skill Deficiency

Previously we examined the case where an operator could not do a job because of some skill deficiency. It is now necessary to consider the case when an operator does have the knowledge or skill to perform but for some reason he doesn't. In general, the remedy for this problem is that of performance management. Rather than modify the operator's skill or knowledge, the conditions associated with the performance, or the consequence or result of the performance, need to be modified. There are four general causes of this type of non-performance:

1. It is punishing to perform as desired.

   When it appears that someone knows how to perform as desired but doesn't, it is necessary to find out whether the desired performance leads to unpleasant results. If so, the remedy is to find ways to and if training seems to be the only remedy, on-the-job training may be easier and cheaper, and just as good as the formal variety (Mager and Pipe, 1970).

2. Does the operator have the potential to benefit from this solution? When considering changing a job to better suit an operator, further consideration must be taken as to whether the operator has what it takes to do the job, either mentally or physically, otherwise the changes could be a waste of time. If the operator doesn't have the potential to do the job, the only alternative left would be to transfer him.

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1. It is punishing to perform as desired.
   When it appears that someone knows how to perform as desired but doesn't, it is necessary to find out whether the desired performance leads to unpleasant results. If so, the remedy is to find ways to

reduce or eliminate the negative effects and to create, or increase the strength of the positive consequences. The cartoon in Figure 10 on page 71 indicates this idea clearly.

2. It is rewarding to perform other than as desired.
Performance may not be as expected because non-performance is rewarding. That is, whether or not desired performance has favourable consequences, they are not as favourable as those of an other-than-desired performance. Clearly then the solution to this problem is to arrange more positive consequence. The cartoon in Figure 11 on page 72 indicates this senario.

3. It simply doesn't matter whether performance is as desired.
Desired performance is less likely to be attained when that performance does not matter to the performer. That is, when the perceived consequence is the same to the performer whether he does it right or not. Thus the remedy that suggests itself is to arrange favourable consequence for desired performance.

4. There are obstacles to performing as desired.
If it looks as though a person knows how to perform but doesn't perform, the reason might be due to obstacles preventing him from performing. The cartoon in Figure 12 on page 73 gives an illustration of this. Obstacles that might get in the way of desired performance could include anything from: lack of authority, lack of time and lack of tools, to lack of direct information about what to do and when to do it. In general most people want to do a good job but when they don't, it is often because of an obstacle in the world around them.

Figure 10. Cartoon Illustrating Punishing Performance

6.2.2.3 Selecting a Remedy

Once a remedy has been found for a performance discrepancy, it is worth thinking about whether the remedy is worth the probable results. The size of the remedy should be compared with the size of the discrepancy. To do so will help select which of several remedies found, may be the most practical, economical, and easiest to use - the one most likely to give the most results for the least effort.

Figure 11. Cartoon Illustrating Rewarding Non-performance

6.3 TRAINING

When confronted with an underskilled operator, the solution to the problem is training. Unfortunately, since training is an easy budget item to cut, training budgets have long been lean in most manufacturing companies (Schonberger,1986). The idea then is to ensure that, if the funds for training are low, all the training that is done is not wasted but is administered properly.

Many of those in the teaching profession, who have studied the learning process conclude that workers in industry will learn and retain only those things which they think they need to know, which they genuinely believe will help them in their work, which they think will most likely help them to solve the problems which daily plague them, and which, in effect, they really want to learn (Feigenbaum, 1983). It follows from this that the

Figure 12. Cartoon Illustrating an Obstacle for Desired Performance

most effective quality control training courses are those which are quality problem centred rather than quality theory centred.

According to Feigenbaum (1983) four principles have simmered out of recent industrial experience and should be used in building a quality control training programme:

- <u>Principle 1 -</u> Keep the training down to earth, and centred upon real company quality problems. Concentrate upon practical, meaningful quality material and case studies.
- <u>Principle 2 -</u> In developing quality control training programmes, the quality engineer and training staff should work and consult with the line organisation to the fullest extent possible, especially in regard to the scope and kind of material to be used in the programmes.
- <u>Principle 3 -</u> The quality control training programmes should be based upon recognition that the solutions to industrial problems are always

changing; consequently, education in quality control methods and techniques can never be considered as completed. It follows that participants in the courses should be strongly encouraged to continue their education on a self-training basis after the completion of the formal courses.

- Principle 4 - The training programmes should, in the long run, included and involve as participants, all levels of personnel from general management to line workers. Since interests and objectives differ widely among organisation levels, individual courses should be tailored to fit these needs.

Quality education and training is a direct and ongoing activity of the company quality system. As such, it must be organised for, with specific responsibility assigned for its various activities. Suitable leadership for the education activities must thus be drawn from across the full line of the organisation as appropriate to the needs of the particular company (Feigenbaum, 1983).

6.4 MOTIVATION

Motivation may be defined as the internal process that causes people to work towards goals that they feel will satisfy their needs (Herzberg, 1968). Applied to quality, motivation consists of discovering and applying the stimuli needed to induce employees to meet their responsibilities with respect to quality.

Motivation for workers is not merely for the purpose of reducing wilful errors. It includes securing worker willingness to accept training and retraining in methods for doing the job, follow the control plan and meet the established standards, and adopt new technology as it is evolved.

Many managers deplore what they regard as a loss in pride of workmanship or a decline in the spirit of 'craftsmanship' which once prevailed among workers. The implication is that workers once were self-motivating with respect to quality and that this self-motivation has been lost. Douglas McGregor (1960) enunciated two sets of propositions and assumptions about man in the organisation: Is the change in the worker or in the work? These two alternatives have been given names - Theory X and Theory Y, respectively.

Under Theory X, the modern worker has become lazy, uncooperative, self-centred, by nature resistant to change, etc. Hence the managers must combat this decline in worker motivation through use of incentives and penalties. Under Theory Y there has been no change in human nature. What has changed is the way in which work is organised. Hence the solution is to create new job conditions which permit the normal human drives to assert themselves. Managers are not unanimous in adhering to one or the other of these theories. There seems to be no conclusive evidence that either can outperform the other in economic terms. Hence it should be understood that while motivation is an essential ingredient for sustained improvement, large potential for both manufacturing and quality assurance lies in the improvement of basic methods and techniques. By involving employees in the development of better ways of doing their jobs, it is possible to obtain high levels of motivation and technical improvements with a high level of built-in employee acceptance.

When considering a motivational package for a company, it is important to know what motivates workers. The needs of industrial employees which are directly related to the job itself appear to be the most important source of motivation. People are motivated by giving them jobs that meet their needs for achievement, earned recognition, responsibility, and opportunity for personal growth (Herzberg, 1968). Figure 13 on page 77 illustrates motivational needs.

To believe that money is the universal motivator is wrong. The value of money as a motivator depends largely on what money represents to a person. Salary increases based on merit or other forms of pay that symbolise real achievement have a high degree of motivational value, but general pay increases, group insurance plans, and many other standard economic benefits which apply equally to all individuals in a company have little, if any, long-term motivational value (Herzberg, 1968).

6.5 CONCLUSION

The 'bottom-line' of this chapter is the message that training and education of workers should be a priority issue in any company. It is important to structure the training so as to obtain the results that are required. The principle results sought from a training programme should include:

1. Identifying the type of operator errors.
2. Reduction of such errors.
3. Training to improve worker techniques.

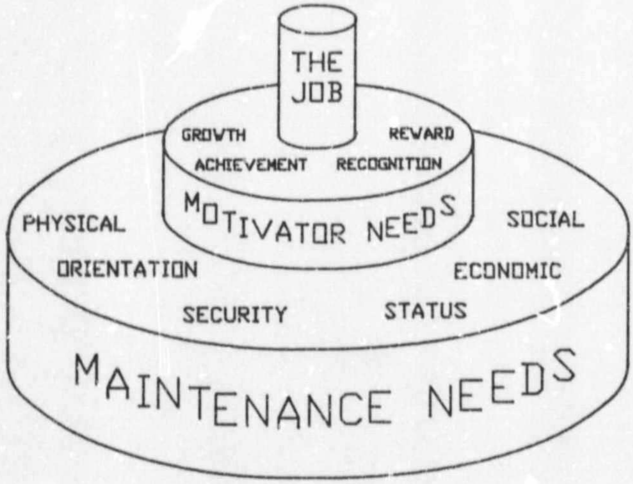

Figure 13. Motivational and Maintenance Needs

4. Ensuring acceptance of technological changes.
5. Motivating the worker to improve quality and productivity.

Of fundamental importance to the effectiveness of a training programme is for it to be consistent with company policy. In other words it should not teach one thing while the company practices another.

Having identified the problem areas caused by worker's skills and attitudes, the next step is to identify the problems caused by the manufacturing process This topic is dealt with in the next chapter.

7.0 PROBLEM IDENTIFICATION

7.1 INTRODUCTION

Identifying a problem and gaining control over the process is found on measurement and study. Voluminous written material is available on how to improve a process, and now many consultant firms offer short courses and seminars on the subject for industrial audiences. Within this chapter an attempt has been made to identify the basic principles and tools needed to monitor a process so that the areas of improvement can be uncovered. This is achieved by following a set path whereby problems are singled out right from the overall manufacturing production down to individual processes. The plan of action is structured for ease-of-use so that the techniques described in this chapter can be implemented immediately with a minimum amount of time needed for training and education.

7.2 PROCESS ANALYSIS TOOLS

When attempting to identify a problem area, by process analysis tools, the keyword is 'simplicity'. A process analysis must be as simple as using a gauge so that everyone in the company from top management to line workers can understand and use it. Schonberger (1986) and Ishikawa (1985) both recommend the employment of the following five primary tools of process analysis:

1. **Process flow chart-** Track the flow of the product through all steps and stages.
2. **Pareto analysis-** (The principle of vital few, trivial many) Plot disturbances at every point in the process flow; select the worst case for further study.
3. **Fishbone charts-** (Ishikawa diagrams) Make the 'worst case' the spine of the fishbone chart. Secondary causes become secondary bones connected to the spine. Tertiary causes connect to secondary causes. Begin experiments on extremity 'bones'.
4. **Histograms-** Sometimes it is useful to measure a process characteristic - perhaps one of the extremity bones - and plot the measurement data on a histogram. The space provides clues to causes.
5. **Control charts-** In many cases it is valuable to plot measured process data for critical characteristics on run diagrams and SPC charts. This allows the full potential capability of the process to be analysed.

The five tools are generally not for design engineers and quality engineers. Design engineers may have a need for higher-order statistical analysis, particularly design-of-experiment methodologies. Quality engineers may need to use multiple regression techniques to investigate complex causal patterns. However according to Ishikawa (1985) as much as 95% of the process analysis can be accomplished through the use of the above tools.

7.2.1 PROCESS FLOW CHARTS

Flow charts show the progression of events through which products are manufactured. For complex products it is useful to prepare a flow chart depicting how the streams of materials move and converge during the processing stages. Such a flow chart makes it easier for all concerned to understand the system design. Multiple departments are involved, in combination with multiple operations, inspections, storages, tests, etc. While departmental supervisors, working in isolation, could plan in a way which would achieve conformity to departmental specifications, the collective results would not optimise company performance. In consequence, it is good practice for some staff specialists to prepare a flow diagram for the entire progression from material to finished products (Juran et al.,1974). Figure 14 on page 81 is an example of such a flow chart as applied to the manufacture of printed circuit boards at MSN Products.
This diagram enables each supervisor to see what goes on before and after his operation. When these supervisors are then convened to discuss planning for control of manufacture, the flow diagram helps them arrive at a plan which optimises company performance, and for determining the logical places to locate control stations. Having identified all the control stations, it is then possible to monitor each station so as to determine the areas of greatest disturbance.

The flow diagram concept can be applied to the entire progression of the product from 'cradle to grave' or to any segment of this progression. For example, Figure 14 on page 81 is the flow diagram merely for production and testing of a printed circuit board. It does not include other segments such as product development, marketing, field service, etc.

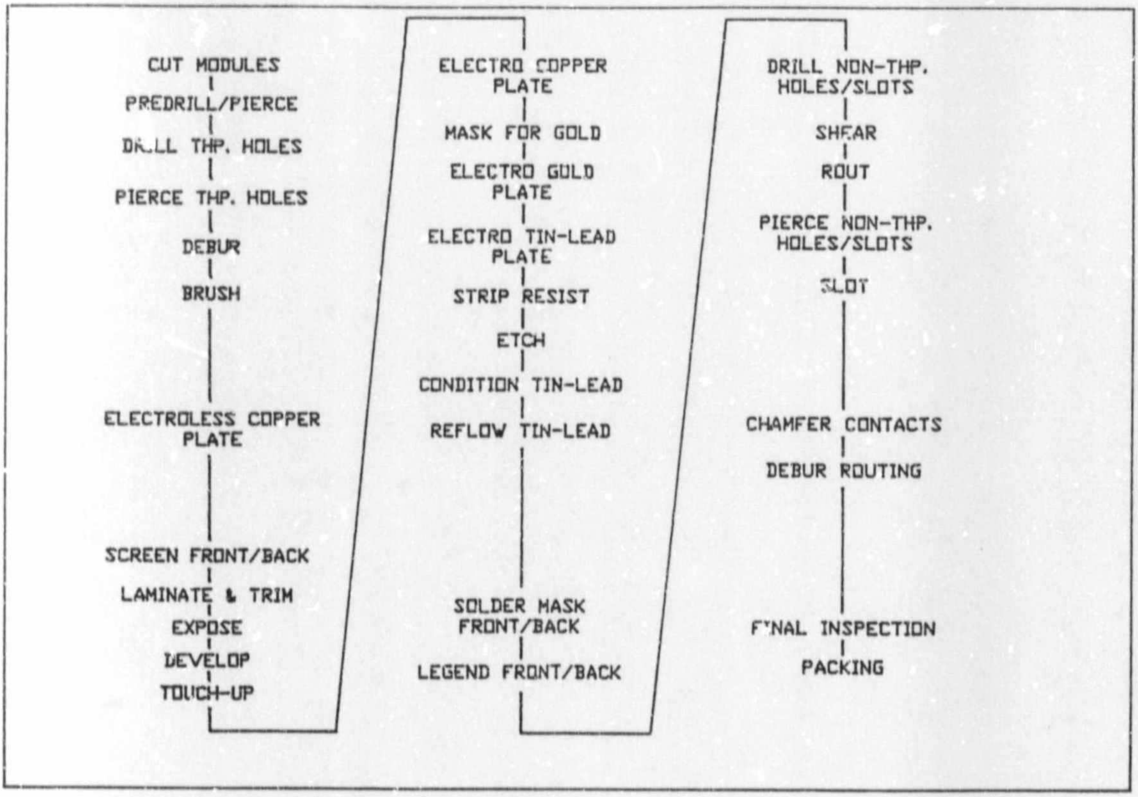

Figure 14. Flow Chart for Printed Circuit Board Manufacture

7.2.2 PARETO ANALYSIS

Managers are well aware that the numerous situations and problems they face are unequal in importance. In inventory control a few percent of the catalogue items account for most of the monetary inventory. (This is the basis of the so-called 'ABC principle' of inventory control). In marketing, a few percent of the customers (the 'key' customers) account for the bulk of the sales. In quality control, the bulk of the field failures, down-time, shop scrap, rework, sorting, and other quality costs are traceable to a vital few field failure modes, shop defects, products, components, processes, vendors, designs, operators, etc.

This phenomenon is not limited to industrial management. In human affairs generally, a few percent of the people own most of the wealth; a few countries account for most of the world's population. The principle extends to biological and other natural phenomena; for example, a few percent of the biological species account for the bulk of the animal population.

What runs through all these phenomena is the principle of the 'vital few and the trivial many'. The vital few members of the assortment account for most of the total effect. The bulk of the members 'the trivial many' account for very little of the total effect. This phenomenon of 'vital few and trivial many' has come to be known as 'the pareto principle' (Juran et al,1974).

A major use of the Pareto principle is in the design of quality improvement programmes. Here the principle has so wide an application that no intelligent approach to quality improvement is possible without it. Improvement can be justified only for the vital few projects. It is these projects which contain the bulk of the opportunities for improvement. The vital few projects are identified through a 'Pareto analysis'. In its most basic form, this consists of a listing of the contributions to the problem in the order of their importance.