Course code: MEC547W

Masters in Engineering Management
Full Dissertation

An Investigation of Measures of Performance in a Complex System

"What gets measured gets done."

(Mason Haire)

Prepared by: **Christopher Maritz**
MRTCHR004

Supervisor: **Prof. Tom Ryan**
S.E.M.
Mech. Eng. Dept.
U.C.T.

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Declaration:

I, the undersigned, hereby declare that this document contains my own original work, and has not, entirely or in part, been submitted to any other university.

Signed by candidate

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1. Introduction

This introductory section aims to prepare the reader by showing what the thesis is about, what its purpose is, and how it was put together. Included here is a brief background of the company National Magazine Printers and a description of the printing process.

Briefly, my position in the company is that of system analyst and facilitator for an improvement projects team. This thesis reports on research that was carried out at National Magazine Printers, over the period February - August 1999. The research began with a three-month action learning phase which investigated the specific operational issue of product quality, and developed further into a study of measures of performance (MOP's) in general. The purpose of the action learning report was to serve as a case study, on which the thesis itself was based.

The purposes of this report (the thesis) are as follows:

- to investigate and report on the various MOP's in use in the company, to critically evaluate them using collected data and by showing the application of relevant theory, and to develop an understanding of how MOP's affect behaviour in an organisation
- to serve as a reference for managers and /or students in the operations field
- to be submitted as a requirement for intention to graduate with a Master of Science degree in Engineering Management in June 2000

The report consists of the following sections:

- introduction
- abstract
- approach to writing the thesis and chapter structure
- chapters 1 to 4
- self-evaluation

1.1 Company background and overview of the printing process

National Magazine Printers (NMP) is a magazine printing factory situated in Montague Gardens, Cape Town, South Africa, employing +-660 staff. It is a division that forms part of the multi-media holding group, Naspers.

NMP specialise in the printing of South Africa's consumer magazines. These include the following familiar publications: You, Fair Lady, Huisgenoot, Drum, Landbouweekblad, Cosmopolitan, Kick Off, South African Sports Illustrated, and others.

Within NMP, the core operations chain may be divided into 3 broad categories, *pre-press*, *press*, and *post-press*. To show more detail, these areas may be further divided into their related parts as shown in the diagram below:

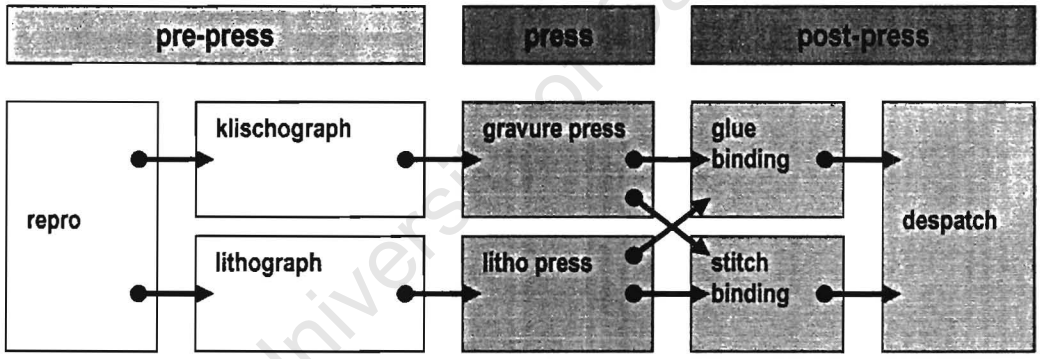


Figure 1: Production workflow through NMP

Repro: This stands for *repro*duction of text and graphics into a form suitable for printing. Repro material may be in the form of digital text and graphics files, or may be physical film or transparencies.

Klischograph: This is the technical term for the engraving of text and images onto copper cylinders. The engraving process leaves microscopic cells in the copper surface which carry the ink and transfer it onto the paper during the printing process.

Lithograph: This is an alternative to the klischograph process. Instead of engraving onto cylinders, so-called "litho plates" can be prepared and mounted onto drums. The microscopic textures left on the litho plates after an exposure process cause the ink to adhere in the required amounts to the required areas. In this way the ink is carried and transferred to the paper in the printing process.

Gravure press: "Gravure" is the name for the printing technology that relies on the klischograph process in the print surface preparation stage. The copper cylinders are mounted in the gravure press and the paper runs between the copper cylinder and an impression roller. The ink on the copper cylinder is transferred directly to the paper.

Litho press: The drums carrying the litho plates are mounted in the litho press. During printing the image on the drum is transferred first to a "blanket" roller. The paper runs between this blanket roller and an impression roller. The ink on the blanket roller is then transferred to the paper. This printing process is different to the gravure process in that the ink is transferred to an intermediate roller (the blanket roller) first, before reaching the paper. For this reason, the litho press is also referred to as the "offset" press.

Glue binding: One way of binding magazines is by gluing the pages together down one side and then wrapping the cover over the pages before the glue dries. This leaves a magazine with a square spine. This binding method is also called "square-back".

Stitch binding: A magazine may also be held together with staples. Double pages are put on top of each other in a saddle fashion and then the spine is stitched, usually in two places. This binding method is also called "saddle-stitching".

Despatch: After binding, the magazines have to be prepared for transport. The magazines are palletised and plastic-wrapped for easy moving onto trucks and for protection during transportation.

2. Abstract

This section serves as a high level summary of the thesis investigation. It will follow the format of Situation, Concern, Question, Answer, Rationale, and Evaluation (SCQARE[1]).

Situation:

National Magazine Printers (NMP) is a printing company that has been in existence for 35 years, and 4 years in it's current location. NMP may be justifiably called a "complex system". There are 5 production departments, 6 non-production (support) departments, approximately 660staff, and there are 2 active unions within the workforce.

NMP forms part of the holding group, Naspers, which is an international multi-media conglomerate. Of the printing work volume that passes through NMP, approximately 50% comes from within Naspers' own editorial division, National Magazines. This portion is traditionally an assured client base. The remaining printing volume comes from the open market.

During mid '98 a business decision was taken to adopt the *theory of constraints*[2] philosophy in production management and to use the associated *throughput accounting*[3] measures instead of traditional cost accounting. A new model for pricing of printing work and financial reporting was developed internally according to throughput accounting principles and has been in place for approximately 18 months. For a similar period a new production planning system has been used to plan the constraint (being the presses in the case of NMP) *first*, and from there the planning for the other departments is derived. This is an application of the familiar *drum-buffer-rope* technique.

[1] Derived from a synthesis of concepts from systems thinking, lecture notes, Prof. Tom Ryan, 1999.
[2] Theory of Constraints (or TOC), as developed by Dr. Eliyahu Goldratt. Application of TOC starts by identifying the constraint in a (production) process, and then "marching" the rest of the system to the speed of the constraint.
[3] Throughput Accounting, as developed by Dr. Eliyahu Goldratt. Throughput Accounting is an alternative financial measure to the traditional cost accounting inherited and practiced by most companies.

In short, the adoption of TOC in the factory meant a natural upset in the sense of an assault on the traditional measures of performance in *productivity* (being efficiencies and utilisations across the production chain), and *finances* (being "product costing", and the consequent ranking of work based on the notion of "product profit").

Concern:

Given the situation as described there are at least two concerns that could be identified. One was the new measures now used in production and financial reporting, and the other was the assured 50% of printing volume "guaranteed" by the Naspers editorial.

The former was an issue of acceptance of the new measures. There are some concepts in TOC which are quite radical when applied to production management and finance, and while training and workshops in TOC principles were carried out, there was naturally still resistance. After 18 months it is still unclear as to whether or not the TOC philosophy has been fully accepted and shared.

The latter situation shows that approximately half of NMP's work is traditionally seen to be the assured client base, being the work coming from the editorial within Naspers. Stemming from this could be the concern of whether NMP has become settled in a secure position with respect to assurance of future work.

At the start of the research, quality was looking like a potential problem, and the chances were that the "normal" ways of fixing it would be tried again, i.e. reimbursing by means of credit notes, client visits, post mortems, also added forms and checklists in the production processes, and others. In other words, trying to out-muscle a *quality problem* with a *quality solution*, or trying to solve a problem on its own basis. This suggests that a new approach is needed to handling quality problems, and perhaps other related problems as well.

"A problem cannot be solved on the same level of thinking that created it." (Albert Einstein)

Imagine a delivery problem in a normal[4] customer - supplier relationship, be it poor quality or late delivery or something like that. The customer may go as far as to take the matter to court. This extreme would not apply in this case because both the customer (editorial) and the supplier (NMP) are part of the same group (Naspers), and a company cannot "litigate with itself". However, in order for Naspers and its subsidiaries to remain viable, this relationship *must* work. Problems seen at the delivery side have to be addressed upstream and designed out. Common sense says that this applies to external clients as well, and arguably to any organisation that offers a product or service to a market.

In summary, the concerns are that:

- when it comes to addressing operations problems, such as poor quality, too much emphasis is placed on obvious / low-leverage / short-term solutions, and
- the shift in production and financial measurements to those as shown in the TOC philosophy has not been total.

Question:

This part will show a *set* of questions that arise from the concern:

- Is the company still in the same security as it was before, say 5 years ago?
- How big is the quality problem? Has quality really become worse or it is customer hype?
- Is quality the only problem? Are there other measures of operations performance that are also worsening, or that may be improving, thereby causing quality to worsen?

[4] "Normal" in the sense of the customer and the supplier being separate (legal) entities.

- Are there unseen, or implicit, measures of operational performance that are causing quality to drop? Is there a muddle in the minds of people with regard to their measures of performance in general, especially after adopting the somewhat radical methods as per Theory of Constraints?
- Are there perhaps problems with communication, or feedback or planning, that preceded the current symptom of poor quality?
- Are there imbalances in permission and accountability in the management structure that must regulate the operations?

Now, a long list of questions like this does little for providing focus. However, quality was deemed to be the issue that needed the immediate attention, so the focus was first put there. The question was asked:

How can NMP address the immediate problem of quality, in the short term and long term, and in the process what can be learned about the process of solving problems in general?

Answer:

Due to the disruption of the traditional measures that TOC caused it could have left some uncertainty in the minds of people with regard to their measures of performance (MOP's). It is possible that due to an existing muddle in MOP's the first one to visibly suffer was that of quality.

Since the issue of quality problems was the "burning platform" that NMP was finding itself on at the time, it was thought that quality should receive the first focus. Then, suspecting that this could be linked to other causes working together, an approach to answering the above questions would be to use systems thinking and management cybernetics principles. Systems thinking suggests that most problems are one of a *set* of problems, and that the visible problems are co-produced by systems of causes. When solutions are attempted, these things should be borne in mind.

"By a mess, I mean a complicated problem where there is no leverage to be found because the leverage lies in interactions that cannot be seen from looking only at the piece you are holding." (Peter Senge, *The Fifth Discipline*, Doubleday, 1990)

A variety of data collection methods was used in order to try and expose this set of problems and underlying causes. These were used in the initial process of action research, which provided data in the form of a case study that this thesis is based upon.

Rationale:

The rationale for the answer is that systems thinking/cybernetics shows that problems don't exist in isolation, and that much of the time there are counter-intuitive solutions. Sustainable solutions do not come from looking at the events that appear to be going wrong. Instead they come from understanding the patterns of events, and then the structure that is responsible for the patterns. The solution then is in understanding and changing the structure.

Part of the structure, as the term is used here, is the design of the measures of performance that the organisation runs by.

Evaluation (on the basis of Relevance, Utility, and Validity):

Relevance:

This criterion looks at the relationship between the Situation and the Concern. It asks if the Concern is *relevant*, given the particular Situation.

In NMP's situation the concern is believed to be relevant as quality, in a sense, is what "gets you to the starting gate". It is a fundamental value attribute that the customer judges the product by. When we see a fundamental measure like this beginning to drop,

then some serious questions need to be asked about the methods and procedures used in the business in NMP.

Utility:

This criterion looks at the relationship between the Concern, the Question, and the Answer. It asks if the Question and the Answer are *useful*, given the Concern that has been expressed.

The set of questions about the system that was given are believed to be useful, mainly *because* it is a *set* of questions; not just an isolated one. The undesirable effect is visible in the measure of quality that is beginning to show problems, but can the origin of this problem and a solution also be found by just looking at quality? Systems thinking suggests that the answer is *no*.

Validity:

This criterion looks at the relationship between the Answer and the Rationale. It asks if the Rationale behind the Answer is *valid*.

An expression of "the problem" is, in fact, a set of causes that have co-produced the undesirable effect that is visible. The answer of using a systems thinking approach is deemed to be valid as it is concerned with the relationships between parts that "manufactured" the problem.

3. Approach to writing the thesis and chapter structure

The approach to this thesis is as follows. During February to April 1999 there was a period of action research that was undertaken at National Magazine printers. This action research account is given in Appendix A, and will now be taken as a case study and analysed. A way to think about this is to regard the action learning report as a technical or laboratory report which is finished and filed away. The next day the lab technician reads the report again, as a case study, and this time asks the following questions:

1. what was the problem?
2. what was done about it?
3. what were the results?
4. what was learnt?

This is how the thesis will be handled and these four questions will become chapter headings. Each chapter will show relevant theory that may be applied in answering the question that heads that chapter. Following that, an attempt will be made to answer the questions using the findings that were made in the research. The 4th chapter, forms the most developed part of the thesis, and tries to show the learning account in detail.

What is now described is how the chapters of the thesis are built. This is done to show the reader what kind of report structure to expect, and to help to add rigour to the arguments made in the chapters.

Each chapter will contain three parts:

First paragraph/introduction: Each chapter begins with a paragraph that tries to answer three questions.

- *what* does the chapter do - what is the transformation process?

- *how* does it do this - what are the elements that work together to make up the chapter?
- *why* does it do this - what is the purpose of the chapter in the rest of the document?

The reason for using these questions is because the chapter can be viewed as a system that must transform information for the reader, as shown:

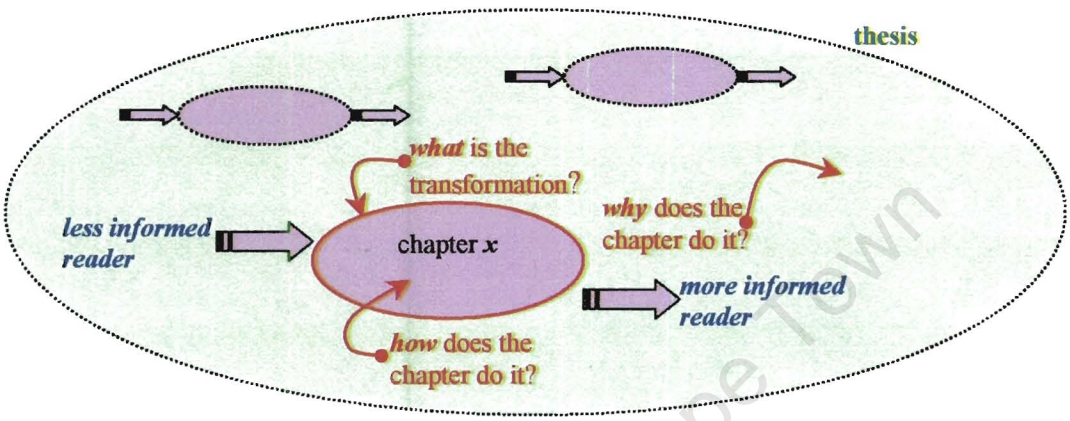


Figure 2: Chapter structure of the report

If the chapter is viewed as a system in this way, then the three systems questions of *what*, *how* and *why* will apply.

Main discussion/body: This part of each chapter will be basically the answer to the question that the chapter heading poses, and will contain the building blocks of some sort of argument.

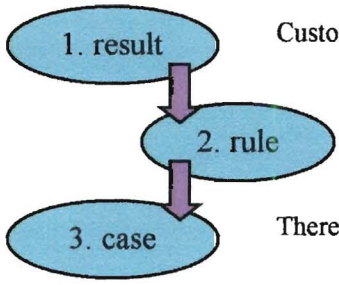
Last paragraph/conclusion: This part attempts to re-phrase the main discussion in the form of either a *deductive*, *inductive*, or *abductive* argument, and in this way must (obviously) conclude something/argue some statement. These three types of arguments[5] each consist of the entities of *rule*, *case*, and *result*, where:

- a *rule* is a theory or hypothesis about the way the world works,
- a *case* is an observed or observable fact that exists in the world, and

- a *result* is an expected or expectable occurrence.

The way in which one argues depends on which of the three entities one starts with, plus what additional entity may be applied. Using this, ways of arguing can now be shown diagrammatically:

Abduction: - (*generates* a hypothesis or rule)

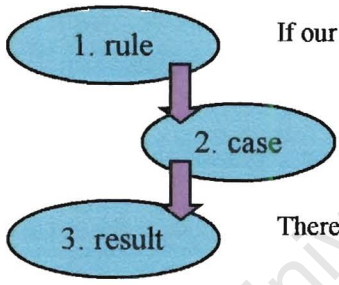


Customers are complaining more frequently than they used to.

A reason for the more frequent complaints is a drop in quality.

Therefore we better check if our quality is getting worse.

Deduction: - (*evaluates* a hypothesis or rule)

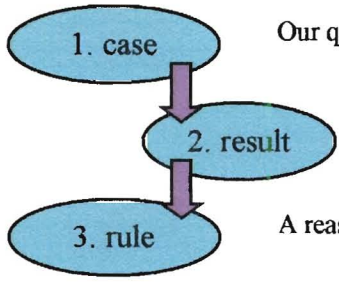


If our quality is poor, then we will get more customer complaints.

Our quality levels are slipping below standard.

Therefore we can expect more frequent customer complaints.

Induction: - (*justifying* a hypothesis or rule)



Our quality level looks like it's dropping.

We are getting more frequent customer complaints.

A reason for the more frequent complaints is the poor quality.

[5] Barbara Minto, *The Pyramid Principle: Logic in Thinking and Writing*, Minto International Inc., 1982

An attempt will be made to use one, or several, of these forms of argument to end each chapter to present a conclusion of that chapter.

While arguments can take on different forms as described, management learning usually begins with *abductive* learning. Abductive learning starts with a result somewhere in the business, some sort of outcome that is puzzling the manager. The next step is to try formulate a theory or a rule that could plausibly explain the result, and so on. This is reflected in the chapter which now follows, which initiates the learning process.

4. Chapter1: What was the problem?

"Before trying to solve a problem, define it precisely. Before defining it precisely, define what you mean by 'defining a problem precisely'". (Eli Goldratt, *Critical Chain*)

Having gone through an action research process[6], this chapter begins the thesis by showing the development of a problem statement. This is done in an attempt to "ask the right questions". This is important because the questions that are asked will determine the rest of the process, which includes describing what was done about the problem, describing the actual results that were observed, and reflecting on what was learnt.

The scientific method[7] lists two types of errors that may be made in a research process. One type is to accept a hypothesis when it is actually wrong, called a Type I error. The other type is to reject a hypothesis when it is actually true, called a Type II error. Mitroff[8] suggests another type of error, which may be called a Type III error. While Type I and Type II errors deal with how "true" a hypothesis may be, a Type III error deals with the actual formulation of the hypothesis itself. Suppose a hypothesis was accepted *and* it happened to be true. There would be no Type I or II error being made, but a Type III error would still have been made *if it was the wrong problem that was solved.*

In this chapter on developing a problem statement, some effort needs to be made in trying to pre-empt and guard against Type III errors. Mitroff offers some advice here, saying that more than one formulation of a problem is a step towards guarding against Type III errors. "A single formulation of a problem is virtual prescription for disaster."

An attempt to show a number of formulations of the problem was made by considering first a systems approach to failures[9], and then following a process of developing a problem statement by attenuating variety[10].

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[6] Appendix A: Action learning report
[7] Learning by formulating a hypothesis (conjecture), testing it, and having done that either accepting or rejecting it (refutation).
[8] Ian Mitroff, *Smart Thinking for Crazy Times*, Berrett-Koehler Publishers, 1998 (summarised with permission in the *Knowledge Resource Book Summary*, Vol8, 1988)
[9] (Victor Bignell and Joyce Fortune, *Understanding Systems Failures*, Manchester University Press, 1984)
[10] Based on lecture notes, Prof. T. Ryan, 1998

4.1 A systems approach to failures

I need to talk about some sort of *failure* within National Magazine Printers. Soon there will be reference made to some problems that were experienced with product quality, and the tendency is to refer to *quality* then as *the failure*. Is this correct? An analogy to help answer this might be to take the example of an earthquake. While an earthquake may cause extensive damage to housing and infrastructure, the earthquake *itself* is not the failure. It would be more appropriate to regard the failure to be lying with the *inability to predict* the earthquake's occurrence, or *not being prepared* for the effects of the earthquake after it happened. In this way the earthquake is a clue which helps to point to where the failure can really be deemed to be. Bignell and Fortune[11] define a failure as *the mismatch between the way something appears to be working and the way an observer would like it to work.*

This is a classic gap phenomenon which will be used here, and may be illustrated as follows:

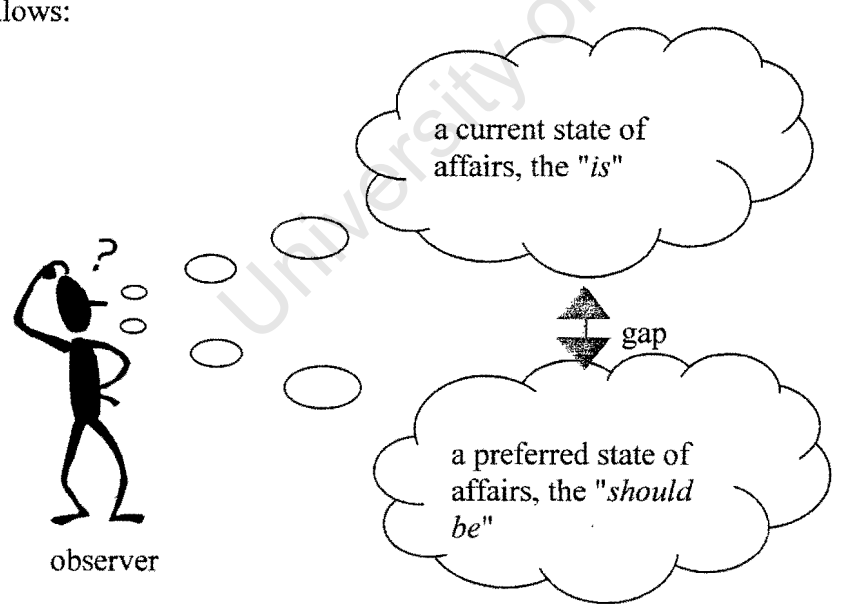


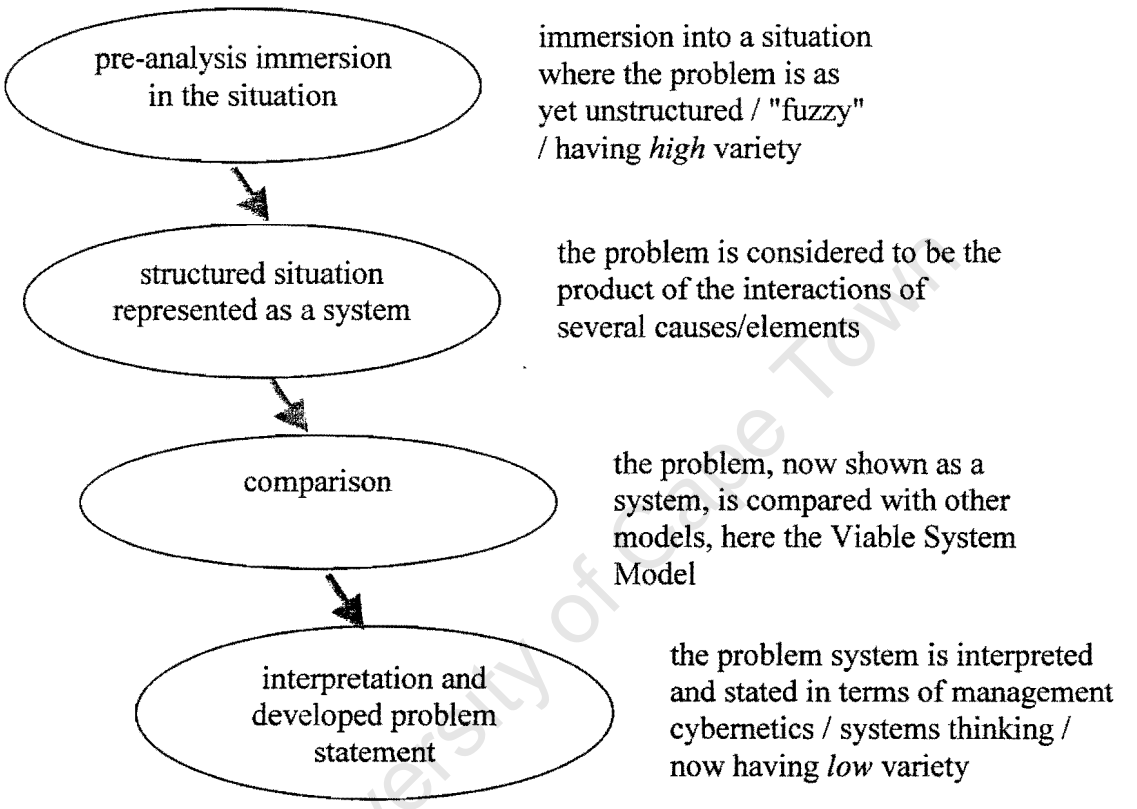
Figure 3: Illustration of gap phenomenon

[11] (Victor Bignell and Joyce Fortune, *Understanding Systems Failures*, Manchester University Press, 1984)

As shown in the above illustration the versions of the "is" and the "should be" both belong to the person observing. A different person may naturally have a different version of the "is" and the "should be". Not only can the versions be different; another person might not even *see* a mismatch between the two. Thus a first step in guarding against Type III errors is to gather a variety of versions of the problem. This is referred to further in the second part of the theory that was considered, developing a problem statement through attenuating variety.

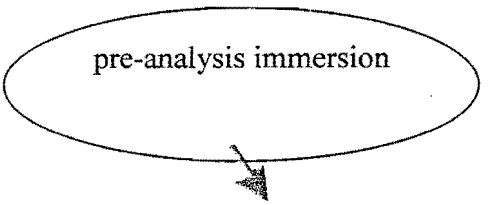
4.2 *Developing a problem statement through attenuating variety*

The steps in developing the problem statement will be shown as follows:



At each stage there will be an attempt at a problem statement shown. The aim is to show how it is developed from a "more fuzzy" problem statement to a "less fuzzy" problem statement.

4.2.1 Pre-analysis immersion in unstructured (high variety) situation



As with any organisation there are a large number of problems as perceived by different people. Looking back at Figure 3, there would be a unique list of problems (i.e. of what the current situation is like, and what it should be like) depending on who is asked.

The immersion stage yielded the following range of concerns:

- low motivation of staff members (factory workers)
- low motivation of some members of middle management (production department heads and shift leaders)
- low press utilisation
- effectiveness of the maintenance department
- increased customer complaints
- product quality levels dropping
- skills shortage
- communication, vertically and horizontally in the structure is inefficient
- not enough focus on customer care
- not enough focus on employee care
- paper waste is perceived to be getting out of control
- improvement projects in the company tend to work initially, but the effects wear off after the project is closed off and the focus is moved somewhere else

The increase in customer complaints and the resulting quality concern was deemed to be the "burning platform" and required the immediate attention. Here the quality concern

may be viewed as a symptom, or an output of some transformation process. If it is viewed as an output of a system, then according to systems thinking there would be a "quick fix" symptomatic treatment and also a longer term sustainable treatment.

This is illustrated in the following diagram:

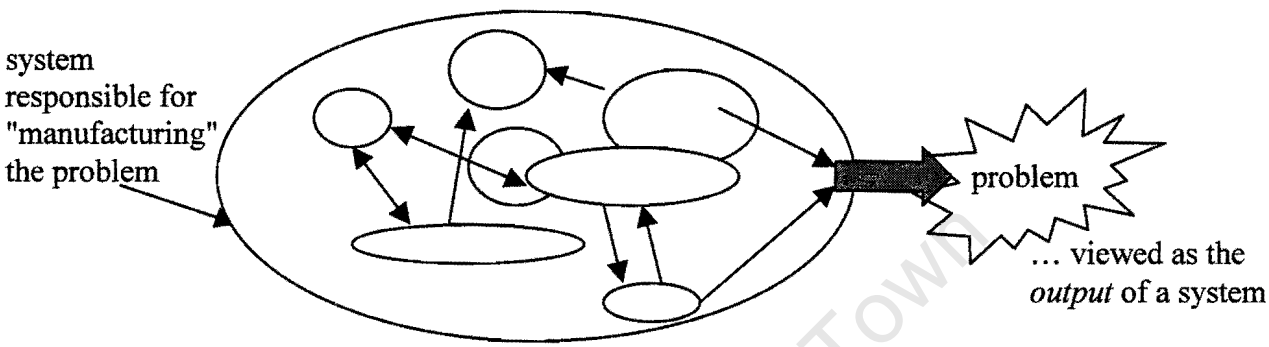
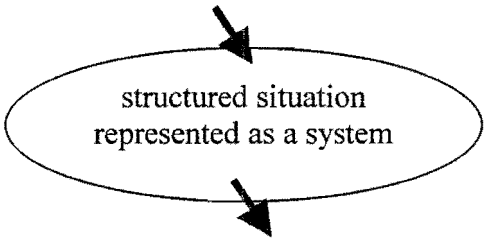


Figure 4: Thinking of the problem as an output of some system

Figure 4 is now used as a basis for the next stage in the problem statement development.

4.2.2 Structured situation represented as a system



In this section the problem is treated as if it is the output of a system. The aim here is to show the elements of such a system, and to try and get a visual sense of how these elements interacted to co-produce the output, or problem.

The following diagram shows Figure 4 redrawn with elements labeled:

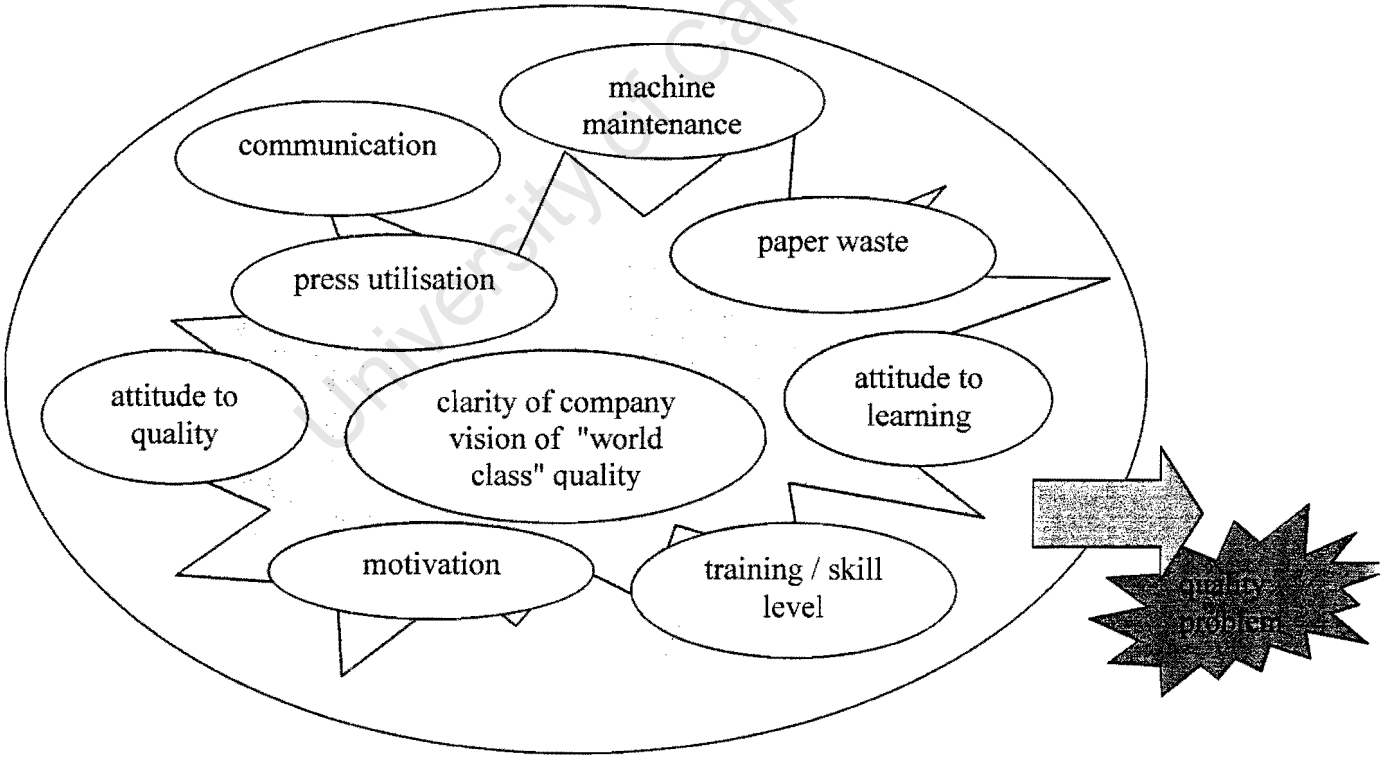


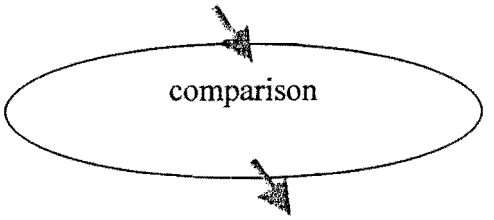
Figure 5: Elements of the system that "produced" the quality problem

At this stage there was no attempt to map interactions between the elements. This was a naming exercise only. What can be seen is that some of the elements that can be thought of as co-producing the output were listed in the range of concerns in the immersion stage. This illustrates the systems principle of networks of cause and effect. It is difficult to say exactly what *one thing* caused another *one thing*. Having said that, it also does not help throwing hands into the air and saying that *everything* causes *everything else*.

Systems thinking shows that problems / happenings / outcomes generally have *sets* of causes. A *decision* was made here to view the quality problem as the output of a system, whose parts co-produced it. The quality problem may or may not really be the output of a system; the point is that it is useful to *view* it as such.

This thinking is preparation for the next stage in problem statement development.

4.2.3 Comparison, with the Viable System Model



A comparison is made here with the Viable System Model[12] (VSM), showing an attempt to phrase the problem in terms of viability / management cybernetics[13], or as a violation of these principles.

- A weakness in the System 2, and the homeostasis principle[14]

The so-called "System 2" (S2) of the VSM is the system responsible for damping oscillations between the System 1 operations as they function together. In other words System 2 must set the guidelines to ensure that the various operations do not "stand on each other's toes" when calling for resources (materials, manpower, time, and others).

For example, if a school was treated as a viable system, then a good example of a System 2 function would be the timetable. The timetable is the "thing" that helps the teachers and pupils to be in the right place at the right time. Of course, in times of stress or duress, the timetable may be violated, for example if a teacher is away and classes need to be combined for a day. The timetable serves as a *guide*.

In a manufacturing plant, part of the S2 function would be the various measures and levels used in production scheduling and inventory control.

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[12] (Stafford Beer, *Diagnosing the System for Organisations*, Wiley, 1985)
[13] (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984) Cybernetics is the study of goal-seeking systems. Management cybernetics is the application of cybernetics principles to the running of organisations, and organisations may arguably fall into the category of goal-seeking systems.
[14] Homeostasis principle: A system survives only so long as all essential variables are maintained within their physiological limits. In organisations, these "essential variables" need to be identified and managed. (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984)

Two measures in use are quality and waste (paper waste) and apparently the S2 is swinging violently between these two. The example of this is where one year there was a drive to reduce paper waste, the following year there was a drive to improve quality, and the year following that the drive was back on paper waste again. There is a perception that there is a direct relationship between paper waste and quality. If paper waste goes down it is expected that quality will drop as well. This is because a contributor to quality is the number of proof copies run before "good" printing; more proofs should help get to good quality, but will also contribute more to paper waste.

Now, an expression of the problem in VSM terms would be to say that the S2 is weak because it is allowing oscillation between measures and there is not sufficient understanding (i.e. not well enough developed model) of the relationship between magazine quality and paper waste.

The homoestasis principle says that the essential variables necessary for survival need to be identified and managed. The problem here is that there is not a common understanding of what these "essential variables" are. There is almost a "flavour of the month" when it comes to what measure of performance is important. One year it was paper waste, another year it was quality, then the following year it was paper waste again. Next it might be customer care, or staff motivation. This is another expression of the System 2 that is weak.

- A weakness in the System 4, and the basins of stability principle[15]

The so-called "System 4" (S4) of the VSM is the system responsible for the "external and tomorrow". The S4 must model the environment and provide the means to prepare and

[15] Basins of stability principle: Complex systems have basins of stability separated by thresholds of instability. If a change attempt does not push the organisation over a threshold into a new basin, then there is a tendency to "gravitate" back towards the old basin. (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984)

shape the organisation for the future. Functions such as research and development, and strategic planning would be typical S4 functions in an organisation.

One S4 function that National Magazine Printers has is a team of people dedicated to improvement projects in the organisation. It is this team's responsibility to study the current processes, and the environment, to try and find areas of improvement / change and then to develop a plan of action to bring about the necessary change. What has been noticed in the past is that improvement projects do bring about change for the time that they are running, but after project completion the effects tend to wear off. This is evidence of the basins of stability principle, where the organisation reverts back to the status quo when the project emphasis is gone.

- The requisite variety law[16]

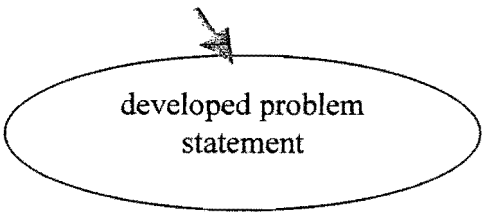
Two characteristics of the management reports that move around the company are that they are *snapshots*, and there are *many* of them. This can cause an overload of information to a manager because of being overwhelmed by a large amount of detail, most of which may not even concern them. Fewer reports that show behaviour over time of essential variables would be more useful and would cause less overload.

"If you emphasise everything, you have emphasised nothing." (source unknown)

Now, having phrased the problem(s) in cybernetics / viable systems terms, the next section attempts to make a comprehensive problem statement.

[16] Requisite variety law: The control achievable by a regulatory system is limited by the variety of the regulator, and the channel capacity between the regulator and the system. These are the limiters of regulation, and hence must be carefully designed.

4.2.4 Interpretation and problem statement



Having followed a process from a "more fuzzy" to a "less fuzzy" statement, an attempt is now made to show a developed problem statement. Heeding the quote introducing this chapter[17], a problem statement should be able to:

1. state *what* the problem is
2. show *how* it came about
3. say *why* it is a problem for the greater system

Then, taking 1) from above, a good problem statement should be able to:

- describe and communicate the problem
- enable learning from the problem
- show what possible solutions/repairs could be

What is the problem?

Here goes: A developed version of the problem would be to say there are 1) many, 2) contradictory, 3) misaligned & misprioritised, 4) "un-empowering", and 5) oscillating measures of performance that are at work in the organisation.

[17] "Before trying to solve a problem, define it precisely. Before defining it precisely, define what you mean by 'defining a problem precisely'". (Eli Goldratt, *Critical Chain*)

How did it come about?

Thinking back to the "engine" that made this problem (Figure 5) the following explanation can be given, looking per point mentioned above:

1) *many MOP's* – There is a feeling that "more is better" when it comes to management information, and this goes for *all* levels - a large number of snapshot list reports fly around. "There is an almighty amount of information flying around this place, the question is who's using it?" (assistant department head)

2) *contradictory MOP's* – A typical scenario may go as follows: People get hammered for poor quality, so the next day they run the press slower to take more care over quality, but then they get hammered for taking too long to get to quantity, so the next day they run the press faster to get to quantity sooner, but then they get hammered for poor quality again, so the next day they try running more proof copies to make sure of quality, but then they get hammered for high paper waste, so the next day they run less proof copies to keep the waste low, but then they hammered for poor quality … and so the story goes on.

3) *misaligned & misprioritised MOP's* - Paper waste[18], department efficiency[19] and department utilisation are prime measures of performance used in production. Stepping away from this, and taking the customer's perspective, would instead raise the measures of product quality, cost, delivery time, and accuracy of quantity & destination as being the prime measures of performance. *These* things are what the customer pays for. The customer does *not* pay for low paper waste, good department efficiency, and good department utilisation.

[18] Paper lost, due to yield, in the process of printing the required amount of copies, expressed as a percent of the paper required to print the exact print order quantity required by the customer.
[19] Efficiency is a speed measure, expressed as (actual machine speed)/(manufacturer's listed "norm" speed)

4) *un-empowering MOP's* - For example, the press hall get hammered for paper waste. The current paper waste measurement system shows that the majority of waste (60% plus) occurs during the printing process. A better statement would be that the majority of paper waste is *measured* at the press, yes, but may be *caused* by a wide variety of problems that happened upstream in the production line. In short, the press crews are asked questions about the high paper waste, many of the causes of which lie outside their department.

5) *oscillating MOP's* - An operational example of this was to look at various performance measures that have been given the focus over the last three years. At one stage there was a paper waste drive, which after some time led to a reduction in paper waste. After this, during mid 1999 (which was period of the action research in the company starting with focus on quality), the quality appeared to improve (by way of decreasing quality error frequency and decreasing money value lost to credit notes). However, during this time the paper waste was deemed to be wandering out of control[20] again. Towards the end of 1999 (by when the action research was completed), the plan for the beginning of 2000 was to institute a bonus scheme, based on paper waste. So far the measures of performance in focus have been paper waste, then quality, then paper waste again. This looks like oscillation between two (seemingly contradictory) measures of performance which could indicate an S2 which is not too well "bolted down".

[20] The standard for paper waste was set at 7% (of the print order, that is to say that to print 100 good copies of a magazine we need to use paper for 100 + 7% = 107 copies). This paper waste figure was continually being exceeded week by week.

Why is it a problem?

This problem, now understood as an output of a system which consists of several elements, could have the following effects on the greater system. Here the greater system would comprise of the value-chain of which NMP is a part, illustrated below:

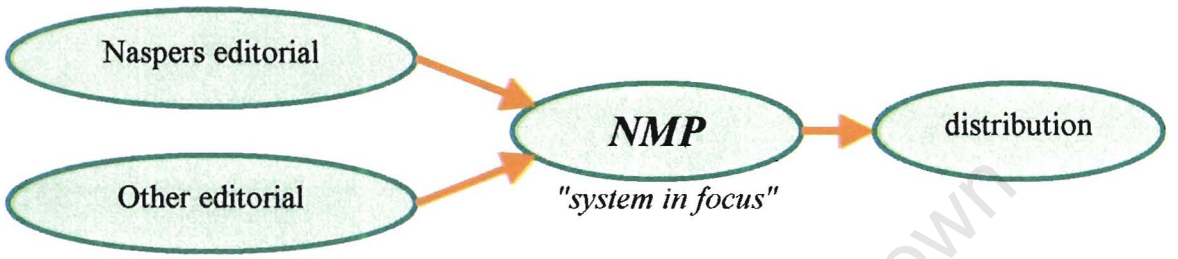


Figure 6: Greater supply chain containing NMP

There are two main reasons why poor quality is a problem, these are:

- Harming businesses

Poor quality is a problem because it harms businesses. A quality product allows its receiver to do something useful with it. The perfect example of this is when NMP print a brochure for a clothing store, for example Edgars. A good quality brochure containing good quality advertisements would assist Edgars in prospering as an organisation and hence would put them in a better position to have more printing work for NMP in the future.

- Stagnating relationship

In the case of Naspers' own editorial, the problem becomes more insidious. In the above example where the client is external to NMP, they are free to take their work elsewhere if quality is poor. Where it is Naspers' own editorial who are the customers, it is not

possible go elsewhere. The other extreme of the customer suing the manufacturer is also not possible because here the customer and the manufacturer are part of the same holding group, being Naspers. In this sense a company cannot "take itself to court". If these are the "rules for playing the game", then at least two outcomes are possible. One is where the relationship prospers and hence both NMP and Editorial prosper. The other is where the relationship stagnates, because of the possibility of poor quality going unaddressed as there is no fear of this customer taking their work elsewhere.

What could possible solutions be?

- Build an understanding between the measures of magazine quality and paper waste. If emphasis on quality goes up then does paper waste *necessarily* go up as well? How does this relationship work?
- Build understanding of the handover of work between departments (including editorial and distribution) in the production process. Is work being passed on by being thrown into the next "silo"? Or is there a handover procedure which clearly shows where the one department's responsibility ends and the other one's starts?
- Explore the thinking behind the choice of MOP's in organisational activities such as gainshare systems and improvement projects. How do the MOP's and resulting behaviour in the small contexts (departments) hold out in the larger whole (NMP)?

5. Chapter2: What was done about it?

"Complex problems have simple, easy to understand, wrong answers." (source not known)

Having arrived at some sort of expression of the problem, the next step was to show what was done about it.

To recap:

There are 1) many, 2) contradictory, 3) misaligned & misprioritised, 4) "un-empowering", and 5) oscillating measures of performance that are at work in the organisation.

Shown now is an overview of the approach used to intervene, and following that a description of the intervention itself.

5.1 Overview of intervention approach

An *action research* process was followed, the main reason being that at the outset of the research, quality was the "screaming" issue that needed to be investigated and understood, but *also needed addressing quickly*. Now, conventional research[21] into an issue in an organisation may improve the researcher's skills and knowledge, but would often leave the system (organisation) unchanged, and for this reason would not be suitable. Action research was more suitable as it provided a framework for the studying of the system as well as changing it during the *same period*, with a high degree of group activity and feedback included.

[21] See Appendix A for a more detailed description of action research, as distinguishable from traditional (conventional) research.

The theory that will be considered here is the essentials of action research[22]. The iterative process of action research is shown below:

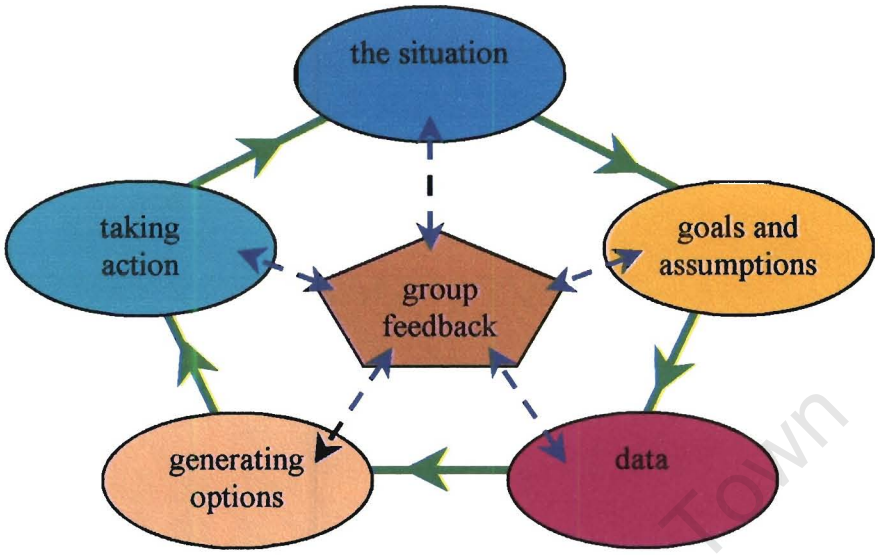


Figure 7: Stages in action research

Briefly, the stages in the action learning are:

- *situation* - what is the problem, or opportunity, that is looking like an issue of concern in the organisation?
- *goals and assumptions* - what must I try and achieve from the action research (i.e. what must change and what must be learnt), and what assumptions will I have to keep in mind?
- *data* - what questions should I be asking, what data will I need to collect to answer them, and what data collection methods should I use?
- *generating options* - what are the possible courses of action after looking at the results of the data collection?
- *taking action* - what option can be taken to create the necessary change and improve performance?

[22] Dr. Abbey Day, International Management Centres

At each of the stages in Figure 7 there should be *group feedback* taking place. At National Magazine Printers a projects team was used in the group feedback at each stage covered in the action learning. This group acted as a support group, reviewing results from time to time and giving feedback on the various actions that were taken.

The action research process will not be expanded upon any further here. A more detailed description can be found preceding the action learning account in Appendix A. What will now be described is an overview, based on the action learning account, of what was done about the problem.

5.2 Overview of intervention

Described now is a summary of the action research process that was followed in intervening. The whole process will not be shown here again. The detailed action research account can be found in Appendix A.

In summary, we tried to intervene by means of:

- group quality inspections & discussions
- building a database history of quality inspection data plus reports
- instituting a channel for self-initiating and self-run inquiry between production departments
- participant observation at group quality inspections
- workshops with factory staff as well as managers of the production departments
- looking at a variety of performance measures other than that of quality
- testing a participative design process for a gainshare system for the company

The key areas of the intervention as briefly described above will now be discussed further.

5.2.1 "Throwing in the line" at quality

Having seen the quality problem as a symptom, and the need to "get it right the first time", we decided that in internal look at quality and quality procedures would be a suitable starting point. There are already a variety of quality checks in place in the production process. These are primarily in the form of checklists and/or end controls. These checks in the production process are shown below (a typical workflow example for a gravure[23] job):

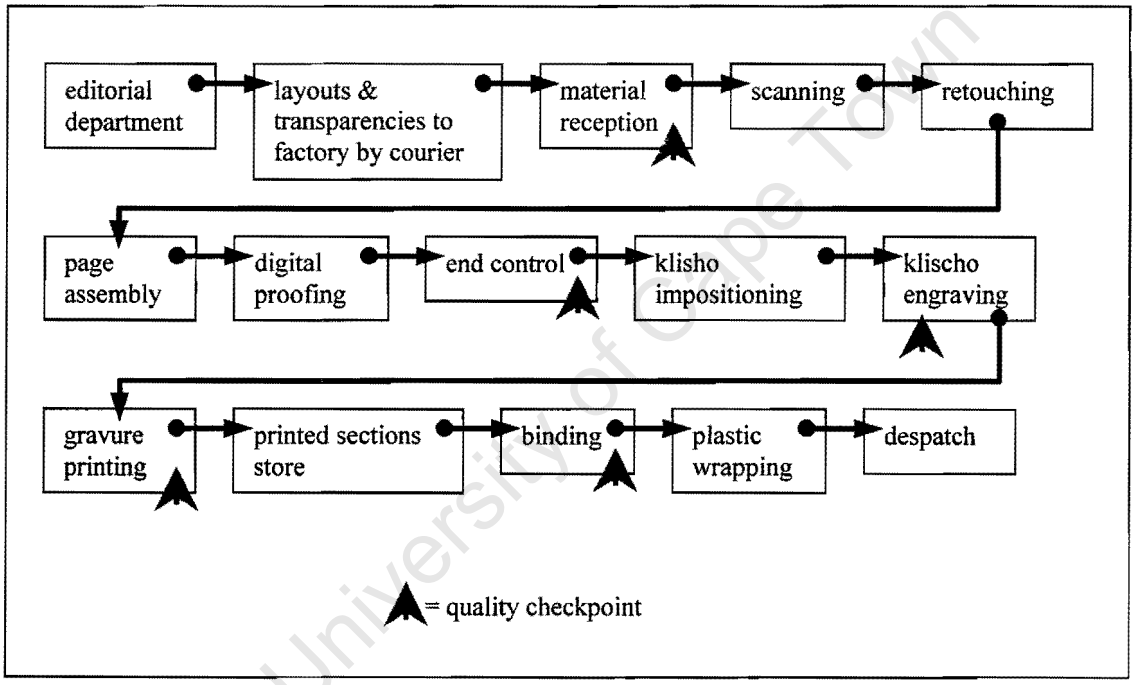


Figure 8: Example of workflow through NMP

The evaluation of the procedures at *each* of these checkpoints would have been a considerable task. We decided that a better starting point would be to examine samples of work, then this could serve as an indicator as to what checkpoints might be examined in more detail later, if need be.

[23] See the Introduction section for a description of gravure printing.

It was decided that, for a start, samples would be taken from the press straight after printing. This was because:

a) the press is the constraint[24] machine, so we can see immediately what the quality of the paper tons throughput[25] is like
b) it is (relatively) easy to gather samples from the press and sit around a table and have a discussion, whereas it would be more awkward to take some form of pre-press sample[26] and discuss that
c) by the printing stage in the manufacturing process, the product (magazine, brochure, etc.) already has comparatively many of its quality attributes that the end product will be judged by

There were differences in opinion regarding how these inspections should be carried out. Two distinct views were:

a) discuss the plan with shift leaders first, then design a sampling plan, or
b) just begin with random inspections first, then inform shift leaders if any problems/patterns emerge

The argument supporting the second option (and against the first option) was that *if* shift leaders were first told about the sampling, then all the checks would be carried out correctly and the quality would probably look good. This would defeat the purpose of the exercise, which was to expose ineffective checks in the first place.

However, what *was* agreed on was that this inspection was for learning and investigative purposes only and not to find "ammunition" to use as blame against somebody, or against a department.

[24] Term used in Theory of Constraints (TOC); the *constraint* in a production line is that part of the line whose rate of production effectively determines the rate of production of the entire plant.
[25] Throughput refers to the rate of production *of the constraint*, and it is therefore the effective rate of production of the *entire plant*.
[26] As examples, a digital file from repro, or an engraved cylinder from klischo, would not be as suitable for inspection as printed sections from the press would be.

We found out that samples of printed matter were already being taken from the presses and kept as backup in case of customer queries or complaints. These samples would also be useful for inspecting and logging data, because the number of samples would be approximately proportional to the length of the run[27] whereas previously, the sample size was random. So, the quality meetings still took place daily, this time using the samples that were already being taken off the presses. Mistakes were logged as they were found and generated daily was a brief report plus a trend graph[28], with examples to follow:

Daily Quality Inspection

Today's date: *Mon 30 August 1999*
Sample date **Mon** *17 May 1999* ***to:*** **Mon** *17 May 1999*

Error type	*Press 5*	*Press 6*	*Press 7*	*Press 8*
belt marks	0	1	0	0
doctor blade marks	1	0	0	0
electrostatic assist	0	0	1	0
folding inaccurate	0	1	1	0
jaw/bekkie marks	0	1	0	0
register out	0	1	0	0
scales not measured	1	0	1	0
smudge	0	1	1	0
streaking	0	1	0	0
Totals per press:	**2**	**6**	**4**	**0**
# samples evaluated:	**3**	**3**	**3**	**6**
Errors per sample:	**0.7**	**2.0**	**1.3**	**0.0**

Figure 9: Example of daily quality report

[27] Even though book size and paper reel width may vary, the longer the run length (i.e. the print order quantity), generally the more paper reels will be used.
[28] See Appendix A: Action research report, for quality trend graph, and trends of other measures.

5.2.2 Designing of feedback

The quality trend graph[29] showed a downward trend, indicating improvement. Now, inspection *by itself* does not usually *reduce* the amount of defective material, but what we were doing every morning was nothing other than basic inspection of material after a certain production process. But there is still a downward trend, indicating that defective material *was* becoming *less* frequent. The reason for this apparent improvement was that the data gathered from the inspection was used to *give feedback* to the crews on the shop floor. This is indicative of the *feedback dominance theorem*[30]. This difference may be illustrated in the following diagram:

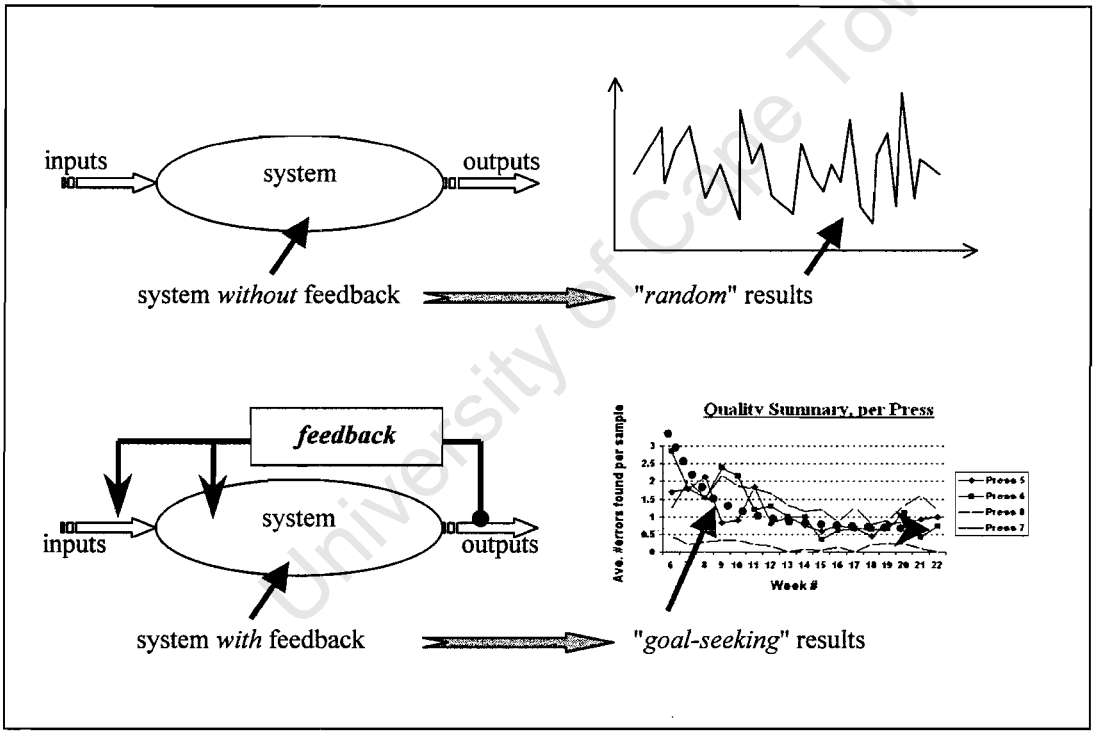


Figure 10: Illustration of the feedback dominance theorem

[29] See Appendix A: Action research report.

[30] The Feedback Dominance Theorem states that for high gain amplifiers, the feedback dominates the output over wide variations in inputs (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984). The implication of this in organisations is that the results produced by an organisational unit is primarily determined by the type of feedback loops that are in place.

After the use of the database for logging quality inspection results there emerged the need for better feedback to people on the shop floor. How does one design better feedback? We wanted to achieve better closure to the communication loop, as illustrated below:

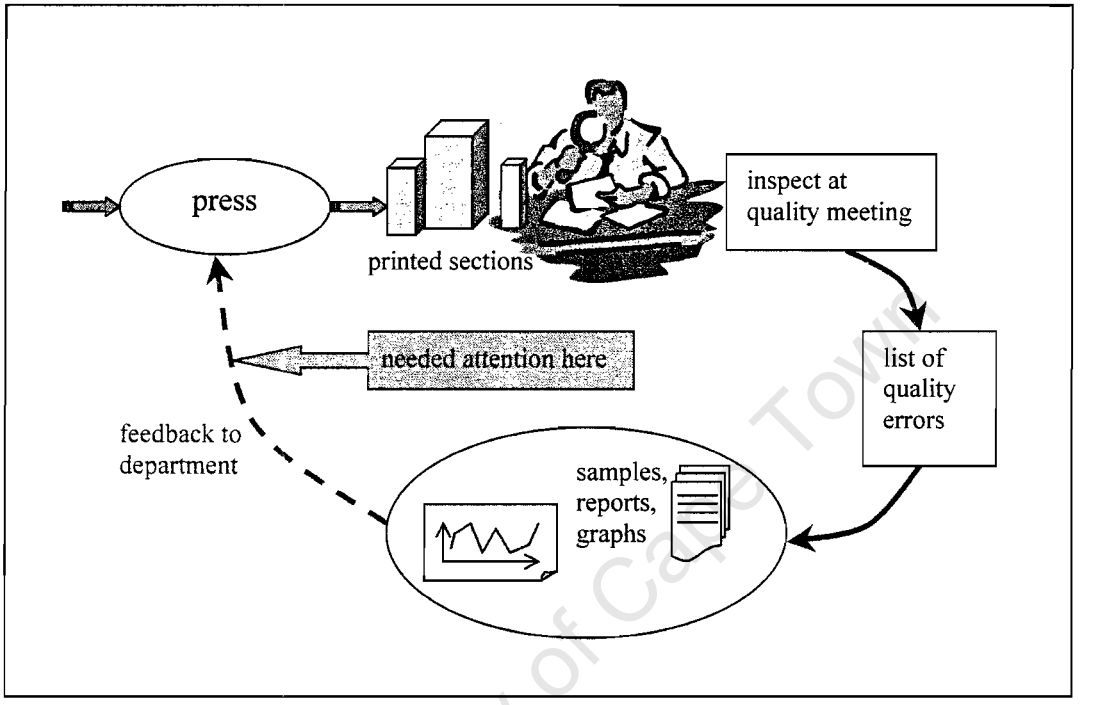


Figure 11: Diagram showing feedback to departments

By saying that feedback was a problem in addition to quality, this may be rephrased as saying that we were managing *actions* and paying too little attention to the *interactions*. This is another expression of a feedback problem, as well as a lack of systems approach.

Further discussion on the designing of feedback follows.

5.2.3 Self-organised channel for quality communication

As it happens, one of the pre-press departments developed a new quality logging and information system for their department. They called this a "non-conformance form", and it came about partly (but not totally) as a result of the quality awareness that was generated by the quality meetings during the early part of the action research. Basically

how it worked was that if there was something being done in the department that *did not conform to a standard* then it was written up on a non-conformance form. The form listed the nature of the problem, a possible solution, and then a name was attached to it. The aim was to get people to think twice before just doing something blindly. The aim was *not* to use the form as a means for disciplinary action. After some months of use, this particular department had built up a substantial history on problem-solving in their department. Now when a problem comes up, the non-conformance history is first consulted to see how similar problems were handled in the past. This history served as a recorded knowledge base for finding solutions quicker for problems.

This appeared to be successful in the department that it originated in. We thought that the same idea could be used *between* departments just as well. This was an attempt to better design feedback. This is shown in the following diagram:

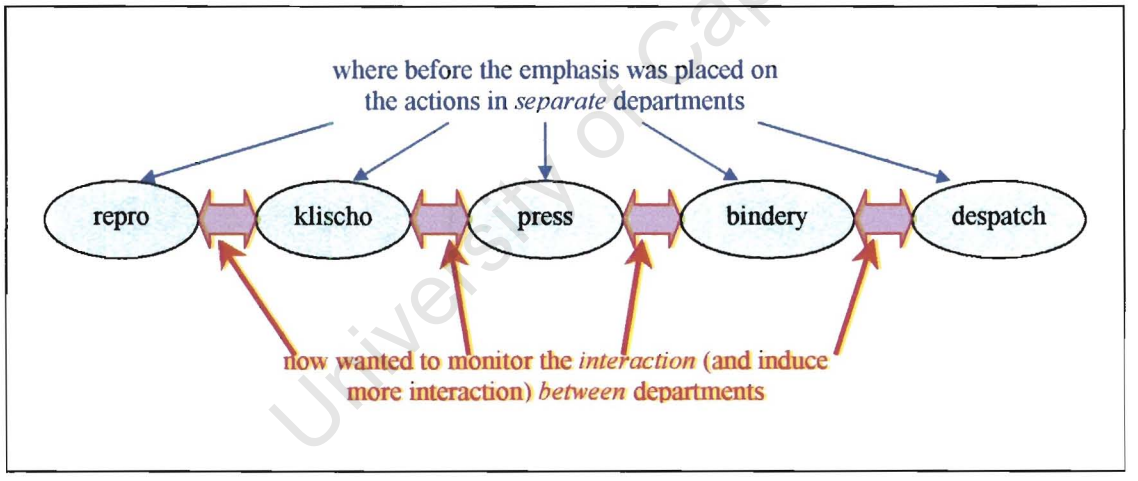


Figure 12: Intention of monitoring "non-conformances"

In this way, the flow of non-conformance forms between departments could be a medium for interaction between departments. Using our definition of "non-conformance", it could be quality that isn't being conformed to, or it could be a consistent late delivery of a certain cylinder type to the press, or perhaps poor folding in the press is causing the bound book to look bad in the bindery. In any case, if a person is not happy with the service from his predecessor in the supply chain, he may initiate a non-conformance

form, and once on the form, his question demands and answer. The form was intended to be a channel for looking closer at the *handover* of work between departments. This is hinting at the management of *interactions*, which is deemed to be systemic management.

"If *this* form works, then we can get rid of all the other forms." (quality & process specialist, NMP)

This is an interesting comment when compared to the comments of one of the assistant department heads, "there is an *almighty* amount of information flowing around this place, but the question is who's using it?" This also showed that we needed to be careful of thinking that just another form is going to suddenly solve everyone's problems. Granted, this did appear to be trying to outmuscle a quality problem *with more forms*, but this was an attempt at formalising the handover of work, and hence the *interaction*, between departments.

6. Chapter3: What were the results?

"Make a habit of discussing a problem on the basis of the data and respecting the facts shown by them." (Kaoru Ishikawa)

A summary of the results of the action learning process will now be shown. Use is made of both quantitative data and qualitative data.

The *quantitative* results will be shown as a set of graphs of trends in a variety of measures of performance, some of which were initiated for the first time in the action learning (quality error frequency trend graph), and others which had already been in use in the company prior to the action learning (other trend graphs like customer complaints frequency, claim frequency, paper waste and others).

The *qualitative* results will be show as a summary of the qualitative data that was collected during the action learning process.

6.1 Quantitative results

Figures 13 to 19 show all the graphical results that were gathered in the action research process. Each will now be explained further, as will be the relationships between them.

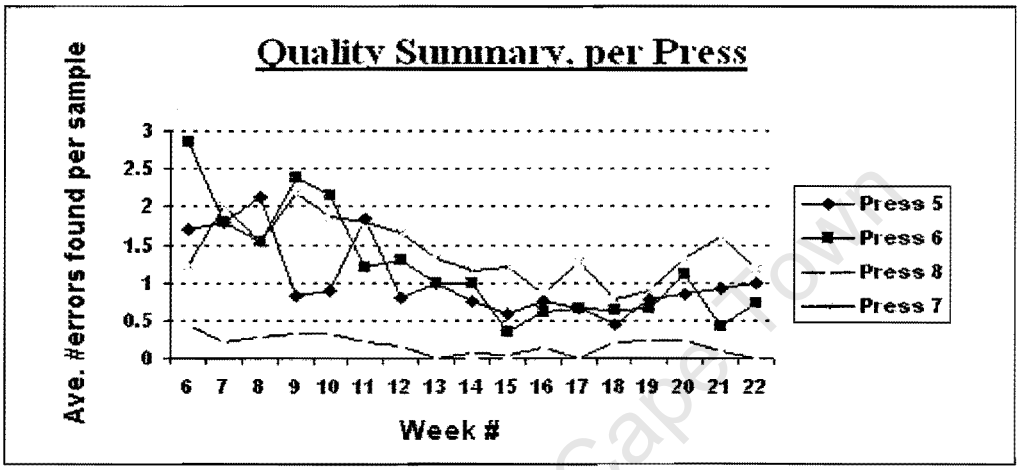


Figure 13: Quality trend graph, from week 6 to week 22[31]

The above quality trend graph indicates a bumpy downward trend in quality error frequency (count), which indicates an improvement during the action research time. However, it is difficult to say if this trend line is "goal seeking" or if it is part of some periodic cycle when taking a zoomed out view. This uncertainty is shown as such:

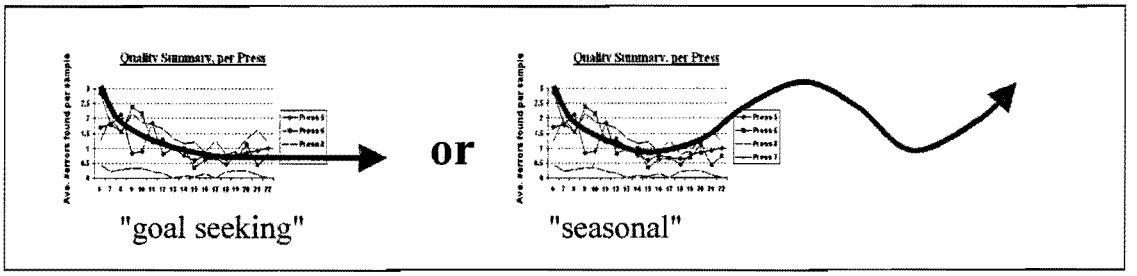


Figure 14: Goal-seeking or seasonal trend?

[31] It is worthwhile noting that while the graph ends on week#22, the actual quality meetings continued to be run on a daily basis. This will be referred to, in later cycles.

Due to time constraints it was not possible to see which trend would be the one to continue. However, it was still possible during the action research time to look at several other measures of performance. The next one was to compare our (new) measurement of quality error frequency with an existing measure of value of credit notes. This is now shown:

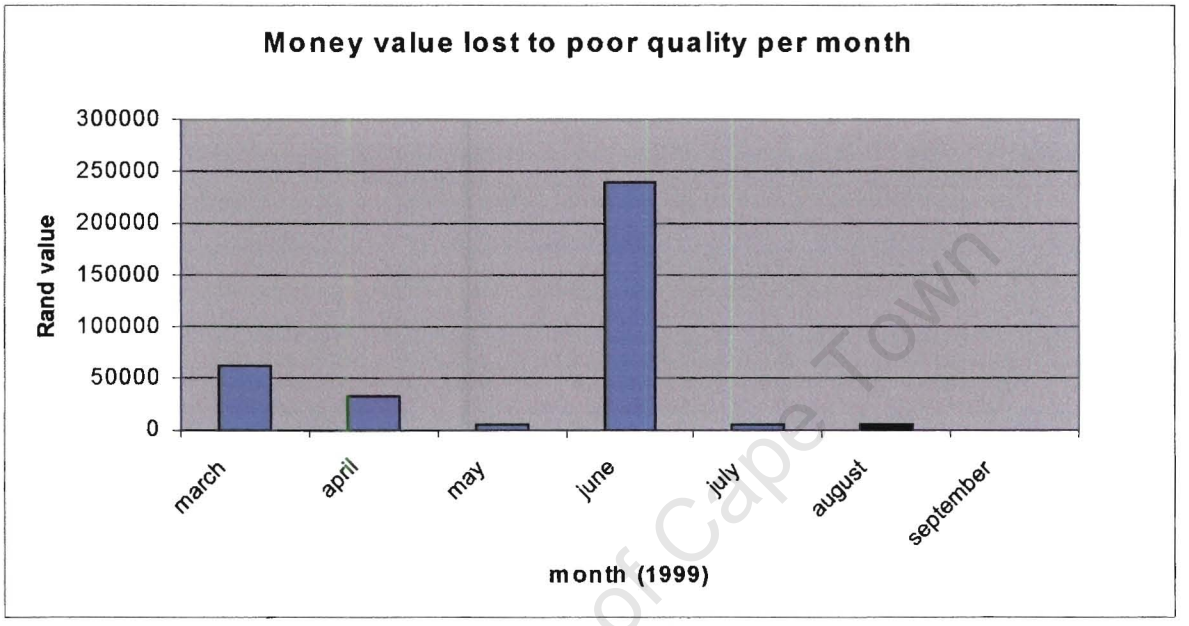


Figure 15: Cost of poor quality, Mar - Sep 1999

Visible from this graph is a downward trend with the big exception of June month with an enormous credit note payment made to a client. The first reaction was to assume then that something went seriously wrong with the quality in that month, but did it? It was found that the credit note total for June was in fact a *single* payment made to one of our most fussy customers. This shows that there is some "luck of the draw" when it comes to looking at money values. If the same quality error (whatever it was) happened to "land" in a magazine whose customer was less fussy, then there might be little or no credit note payment. This says that money lost to quality and quality level itself are not directly proportional in the short term, or when looking at isolated incidents. It is expected that there may be a more visible relationship in the longer term (i.e. a period greater than the period during which action research was carried out).

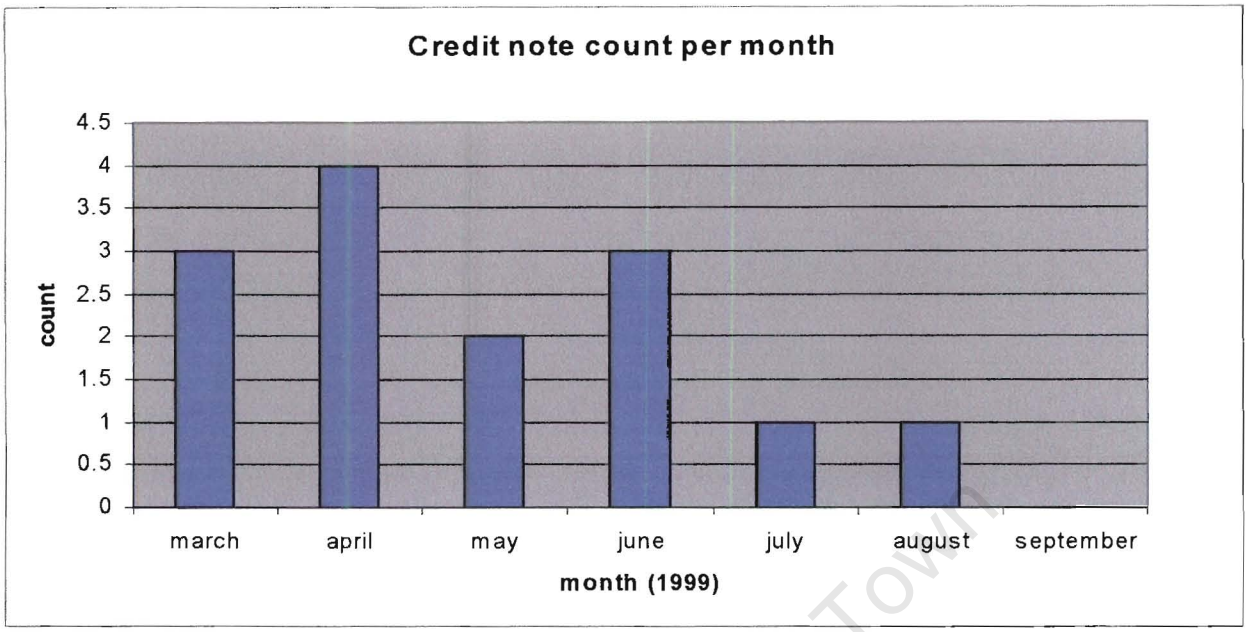


Figure 16: Credit note frequency, Mar - Sep 1999

The credit note claim frequency shows a bumpy decline over the months. This has a closer relationship to the quality error trend graph than that of credit note value already shown. This makes some sense as both the quality error count graph (figure 13) and the above credit note count graph are *frequency* measures, and are more robust against a "luck of the draw" effect as the trend of credit note *money value* (figure 15).

The frequency trends so far are a reflection of the level of quality problems, while the credit note value trend reflects the *customer's reaction* to these quality problems, which may be erratic.

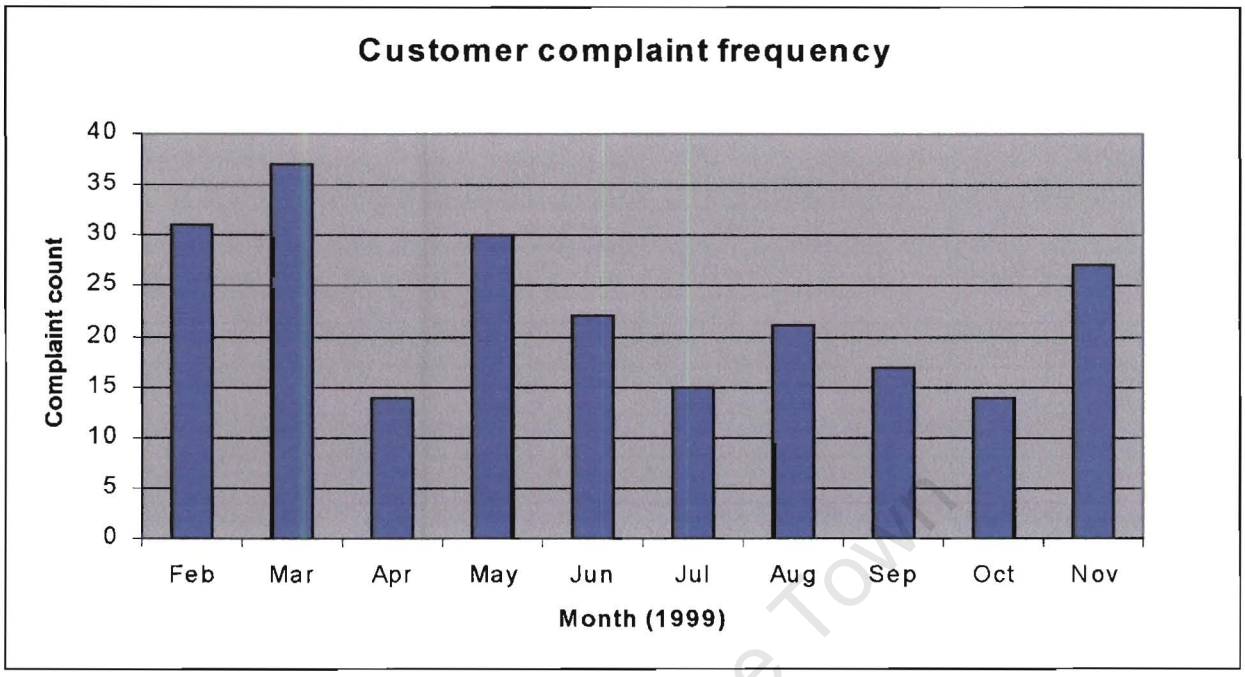


Figure 17: Customer complaints frequency, Feb - Nov 1999

Visible in this graph is a trend similar to the bumpy trend in the credit note frequency graph, with the difference that it leads the credit note frequency trend by one month. It might be expected that some percent of the complaints could take about a month to manifest themselves as actual claims for refunds.

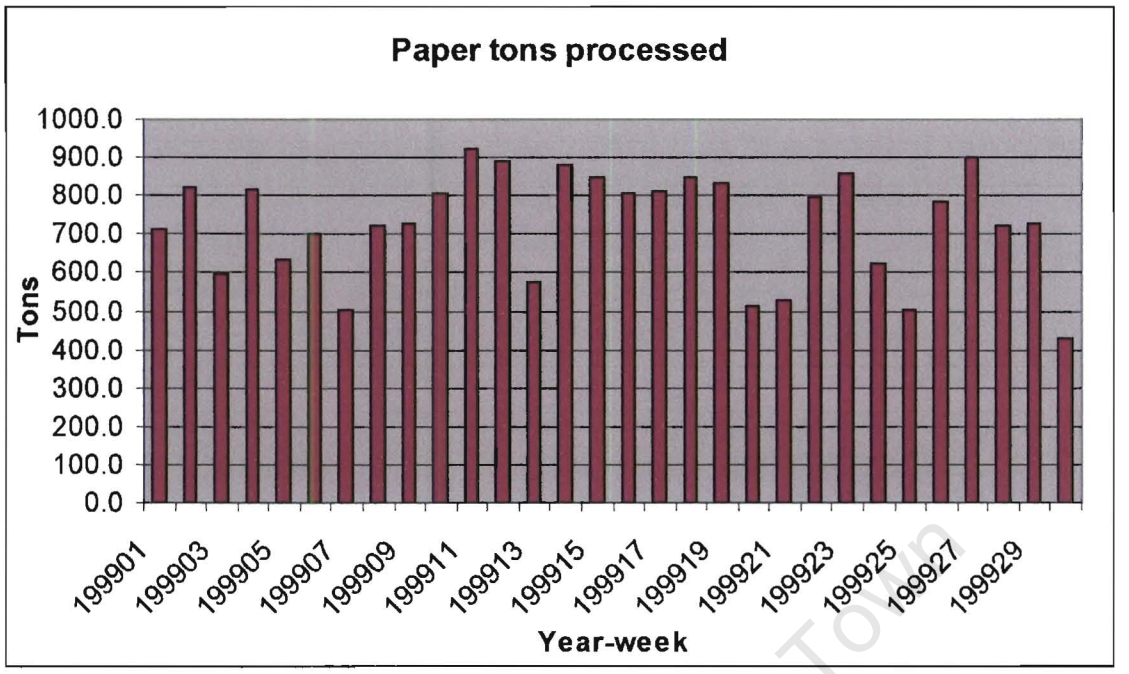


Figure 18: Paper tons processed for week 1 to 30 (1999)

The paper tons is an indicator of the loading on the constraint (in NMP's case, the presses), and is therefore a global indicator of the loading on the entire plant. There does not appear to be a correlation between quality error frequency and paper tons throughput. The peak capacity of NMP is in the region of 1000 tons per week. One might expect that if the loading figure got close to this, then there may be pressure to push work through at the expense of quality. While this hypothesis may be logical, the data (figure 13 and figure 18) does not support this.

Figure 19: Paper waste figures for week 1 to 30 (1999)

The above graph shows the paper waste as a percent of the total print order. Comparing this trend to the quality error frequency trend (figure 13) shows little correlation between the two. One of the arguments was that if quality goes up then paper waste must necessarily *also* go up because improving quality was deemed to require running more proof copies to fine tune the magazine quality. This hypothesis appeared not to be true according to the trend graphs.

6.2 *Qualitative results*

Qualitative data was collected by means of planned workshop sessions, and unplanned participant observation during quality control meetings. Following is an attempt to make some sense of these results.

Attitude to quality:

- Quality is necessary to keep customers
- Bad quality costs money in the long term
- Good quality makes money in the long term
- The quality of NMP's outputs is sometimes at a high level, but is not sustained
- Quality is not confined to materials – people, time, managers, and information also have quality associated with them

In summary, people seem to understand quality and know its importance, but somehow NMP still struggle sometimes to get it right and *keep* it right.

The "preventers" of quality:

- poor quality of raw materials
- misinformation, or information not "transparent"
- training / skills
- low level of motivation and not using ideas from the shop floor
- commitment to quality difficult due to "double-standards" and tendency to run to quantity because of time pressure
- poorly identified and documented quality standards and procedures

6.3 Comments on results

The quantitative data showed results contrary to the rather firmly held belief that if quality must go up then paper waste must do the same. What also emerged as interesting was the possible dangers of using a financial measure to gauge the quality level. Obviously quality has a measurable financial impact, but the consequent money value it is largely dependent on the nature of the client who is on the receiving end of the bad quality, and not the severity of the bad quality itself.

The qualitative data showed that there are many pressures in the way of other measures of performance that may work in opposition to the measure of quality. Time pressure, and the resulting double standards, can lead a person to lose interest because they can never make their supervisor happy, nor their client. People knew about the importance of quality, but there appeared to be other things, be they time pressure, motivation, procedures/"red tape", communication channels, interaction between departments, and others, that are preventing them from achieving good quality. More quality control and checklists is not going to have a sustainable impact on quality. The leverage lies in understanding and addressing the areas that are preventing good quality from being achieved.

7. Chapter4: What was learnt?

"There is divine beauty to learning. To learn means to accept the postulate that life did not begin at my birth. Others have been here before me, and I walk in their footsteps. The books I have read were composed by generations of fathers and sons, mothers and daughters, teachers and disciples. I am the sum total of their experience, and so are you." (Ellie Wiesel)

Having looked at the results, this chapter now tries to give an account of the learning that took place. It is based on a reflection of the process as covered up until now. This chapter first outlines a framework for learning and the elements of what might be called a *learning system* will be shown here, as well as how they interact. Developed from these interactions will be a model to guide reflection on a learning process which will then be used as a framework to describe the learning.

7.1 The learning system and its elements

There are four main sub-systems that can be seen to make up a *learning system*[32]. These are shown in the following diagram:

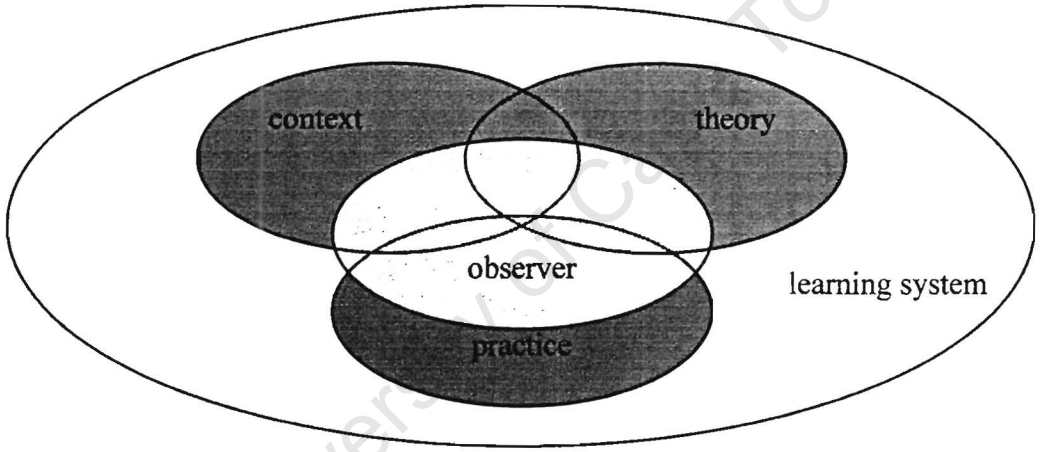


Figure 20: Diagram of a learning system

The four elements are shown merged together, as may be expected in real life. They are:

Observer: This is the person who is attempting to learn, i.e. me.

Context: I (the observer) exist within some sort of context. This would include my surroundings and the people with whom I interact. In other words it is my physical and

[32] Derived from a synthesis of concepts from learning and systems thinking, lecture notes, Prof. Tom Ryan, 1999.

psychological environment. The context can be very general, in the sense of the whole universe, or it can be very specific, e.g. my family, my church, my workplace, etc.

Theory: Some set of beliefs/rules/assumptions forms the basis of the decisions and actions that I take, and determines the way that I see the world. This is really my current version of how the universe works. This theory is constructed largely from the various inputs from my environment, or context(s).

Practice: I (the observer) go about certain activities and on a day to day basis, and I exhibit some sort of behaviour. This forms the practice element of the learning system of which I am a part, and my actions are based largely on my mental model, or theory.

Now, *systems thinking* says that a system's properties as a whole are not determined by the sum of the individual contributions of the sub-systems, but rather are determined by the product of their *interactions*. Hence, if I speak of a learning *system*, it follows that the *interactions* of this system need to be examined further. This will be done now.

7.2 *Interactions between the elements of the learning system*

As already shown in the previous diagram, the four elements of learning are merging into one another. For the purposes of examining their interactions, the following diagram shows the same elements, this time pulled apart:

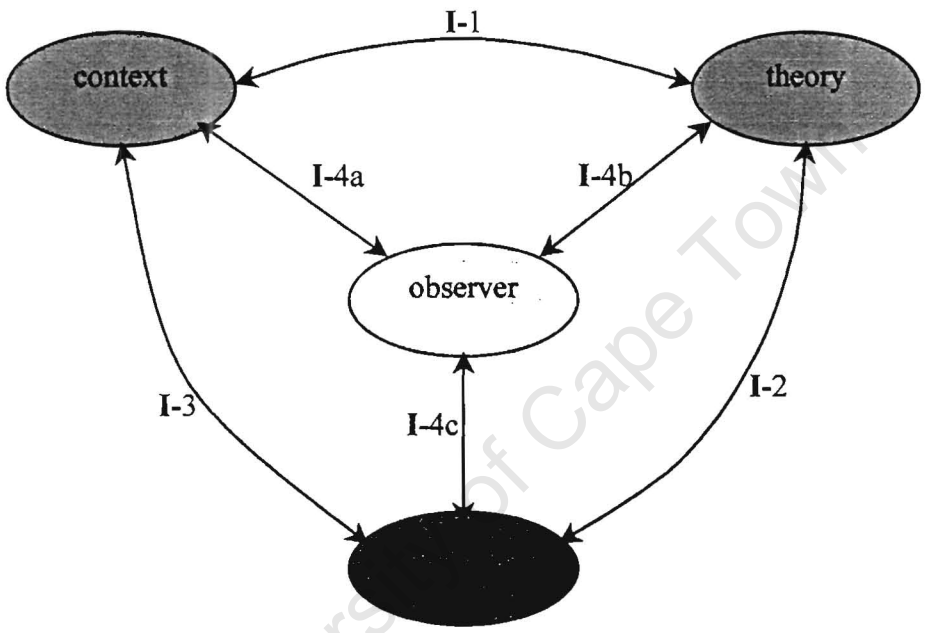


Figure 21: The learning system with elements pulled apart

The interactions have been labeled I-1, I-2, I-3, and I-4a to I-4c in order to refer to them specifically. "I-1" means "interaction #1", "I-2" means "interaction #2", etc.

I-1: Interaction #1 occurs between the context and the theory. Inquiry processes usually begin with some issue arising out of the context that is puzzling the observer. Perhaps he/she doesn't have a theory to explain it, or maybe he/she has a theory but it is suggesting something different to what is actually happening in the context. In either case, the process of interacting between context and theory is really the *development of a problem statement*. The more interaction, the more developed the expression of the problem will be. This is the first interaction.

I-2: Interaction #2 occurs between theory and practice, and logically follows the development of the problem statement. Interaction between the theory and practice is what generates the *design of the intervention.* This is really the plan of action that is deemed to be able to address the problem that was expressed in interaction #1.

I-3: Interaction #3 happens between the practice and the context, and logically follows the design of the intervention. Interaction between practice and context is the *implementation process*. This is really the carrying out of the plan that was designed in interaction #2.

These are the first three interactions. The remaining interactions will now be described, under a separate heading, as they will form the framework for this last chapter on describing what was learnt.

7.3 Reflecting on context, theory, and practice - a framework to describe learning

The remaining interactions are as shown below:

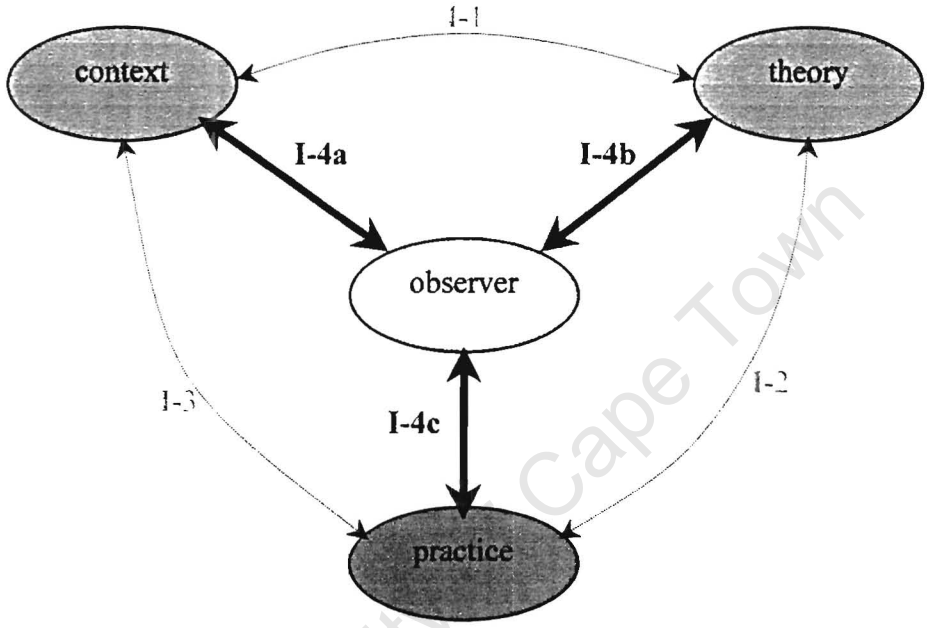


Figure 22: Framework for describing reflection and learning

After developing the problem statement, designing the intervention plan, and implementing the plan, learning would be incomplete without returning to the observer for a period of *reflection*. To reflect is a critical part of *experiential learning* as described by Kolb[33]. Interaction #4 is a way of going about this reflection and consists of three parts:

I-4a: I (the observer) need to look at the context again and ask how I have improved my understanding of it, and how I have influenced it.

[33] David A. Kolb proposes that a model of how people learn may be conceived of as a four stage cycle of *concrete experience, observations and reflections, formation of abstract concepts and generalisations*, and *testing implications of concepts in new situations*. Learners, if they are to be effective, need to visit these four different kinds of abilities.

I-4b: I need to look at the theory again and ask how I have improved my understanding of it, and what contribution I have made to the "body of knowledge".
I-4c: I need to look at my practice again and ask how I have improved my understanding of it, and in what way I have changed my behaviour.

These three steps of the reflection stage complete the description of the learning system and the interaction of its parts. Following now is each of the three reflection stages explained in detail.

7.4 Context

Recap on I-4a (figure 22): How have I improved my understanding of the company and the variety that takes place under its roof? And how have I changed the way the company works?

These questions will now be addressed in the following discussions.

7.4.1 Understanding the company in respect of quality

There was an interesting tendency that surfaced when looking at attitude to quality. There was a tendency to add things to checklists all the time. What I mean is that if there was some undesirable feature creeping into the output of a particular production process, then the "solution" was to look back in the process and add that feature on a quality checklist with the aim that the problem should now be checked for and should not appear in the output again. This is not a bad idea and may work (and *has* worked) the first few times. The problem is that if this process of adding continued there would be a growing checklist that a person would have to use and ultimately some items would end up being ignored, hence old problems potentially surfacing again in the output.

Russel Ackoff[34] uses a systems thinking approach to addressing problems and suggests that four treatments of a problem may be to *solve* it, *absolve* it, *resolve* it, or *dissolve* it. The last of these, to "dissolve" a problem, is the treatment that is preferred as it involves the *(re-)design of a system so that it is impossible for the problem to surface again*, even in a different guise. In this sense, problems are *designed out of* a system. This approach would be of use in the quality checklist example mentioned above, and from point of view there should be constant striving to *remove* items from quality checklists through redesign[35].

[34] (Russel Ackoff, *The Ackoff Tapes*, 1991)

[35] At a stage during the action research there was actually one attempt to (unknowingly) do this. There were problems experienced with getting, and keeping, register during printing, due to paper expansion and

7.4.2 Understanding the company with respect to measures of performance in general

"*We run for quantity in this place, not quality.*" (shift supervisor)

This was a worrying quote that came from the shop floor. This is an indicator of a *theory in use*[36], despite the emphasis recently put on quality. Operators on the shop floor are supposed to be empowered to be able to "stop the line" at any time if there are quality problems. However, the usual response to an operator stopping a machine, for any reason, is something like (colourful language left out) "are you *mad* you can't do that!"

Systems thinking says that MOP's rarely exist alone. While quality looked like a problem in the first chapter, we saw the MOP of *time* also playing a role. For as long as the production process was behind schedule, there would be outwork. For this reason, I would be making a (systemic) mistake if I was trying to investigate quality without at least looking at the product lead time, and product cost as well. Together these form a *system* of measures that affect each other.

This may be described as a typical "hockey stick" syndrome, which is as a result of a "double standard" that is being used. Startup copies during a print run are checked for folding, register[37], and colour. Once all these are satisfactory then the copies at that moment are the so-called "advance copies", meaning the first copies that are "on specs" as far as print quality is concerned. If requested, these copies are the first to go to the

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contraction during printing. In gravure printing technology, there is a measurable difference in paper reel width between where it enters the press (white paper) and many meters later where it exits the press (paper printed with four colours, both sides). To help prevent a range of press adjustment problems during the printing process, the upstream stage of preparing the image-carrying rollers (cylinders) was adjusted to compensate for the measurable difference in paper width. The result was a print run with much less disruptions in the way of having adjust to the press all the time to keep register in. In other words, the result was a problem that was *designed out of a system.*

[36] Chris Argyris, *Overcoming Organisational Defenses*, Allyn and Bacon, 1990

[37] The extent to which the three primary colours (magenta, cyan, and yellow) and black "fall" on top of each other. A colour image that is "out of register" would look blurred and would strain the eye.

client, "hot off the press". For the rest of the run the work is monitored and tallied until the print run is complete. The advance copies, ideally, reflect the rest of the run.

In reality there is nothing stopping the behaviour of "run to quality" until advance copies are out, then crank the press speed up and "run to quantity". In this way "by the book" quality is what counts at the beginning of the run, and towards the end it is speed only, because of time pressure and/or to beat the tallies of the previous shift. This is the "hockey stick". It is this kind of behaviour that the non-conformance forms of the previous chapter aim to address.

There certainly seemed to be a "flavour of the month" when it came to putting emphasis on different measures of performance. In a sense this is opposite to what could be called a "maintained balanced scorecard" approach. Instead of keeping a balance between many measures of performance, there is a tendency to hop between them. This may be a violation of the homeostasis principle, which is the maintaining of a *set* of essential variables to ensure that none of them move beyond their physiological limits.

7.4.3 Influence on the company / how the company performance changed

A summary of the influence on the company that this research has had is as follows. As is observable in the results, quality measurably improved for a period, with apparently no influence on paper waste trend during the same period, and an apparently good effect on customer complaints frequency and claims frequency.

Maintaining of a quality database took considerable effort. This would mean a significant amount of time to maintain it, so the first effect on the context/work environment was that measuring quality meant some added work. If the use of this was going to be continued then the effort would need to be justified. For this reason, operators on the presses were informally asked if the reports and graphs were actually useful to them. The response from some was that they did take it to heart and they wanted to be kept up to date with the quality levels of their own presses, as well as to

compare their quality with that of other presses. Others' response was that it was "just another report" floating around, and not much attention was given to it.

What also emerged was the dislike of someone such as myself investigating the quality of the work of another department. This is referred to in the reflection on behaviour (practice). Several times, when following up a quality query I would go to the press and ask the department head/shift leader/machine minder; whoever was available. Several times the response was along the lines of "when are *you* going to come and work in this department and then *you* can try and solve these problems?" Personalities are immediately attached to the questions being asked. The response to the same question would be very different if the person asking was a client, or a department head, or the managing director. Similar thinking could be applied to the actual quality meetings themselves. If I was a machine-minder attending one of these quality meetings and I saw my department's mistakes being written down all the time by an "outsider", I could very easily grow to dislike the whole idea of attending quality meetings. This is referred to in the discussion on understanding behaviour.

Aside from the quality data and logging side of the initial stages of action learning, there was another aspect that arose, that of the learning that took place at the quality meetings. Certainly the very first stages of the quality inspection was when I learned the most about the technical side of quality and the printing process. In principal, the same could apply to anyone sitting at the table. The quality meeting looked like a good vehicle for *interdepartmental learning*.

The data showed a decline in the marginal improvement of quality. This indicated that the system, or the idea, was losing impact. This suggested evidence of the law of declining marginal utility[38]. This doesn't mean that the idea of having joint quality meetings was a *failure*; it shows that there is room for (re)design of the system in a more creative way.

[38] Or the "Pareto principle" (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984)

7.5 *Theory*

Recap on I-4b (figure 22): How have I improved my understanding of the theory? How have I contributed to the body of knowledge?

These questions will now be addressed in the following discussions.

7.5.1 What constitutes a contribution to theory?

To answer this question, Whetten's[39] approach will be used which is to look at the building blocks of theory development. He suggests that there are three questions, of what, why and how that may be asked of the process. More specifically:

What factors should be considered to explain the situation that we are interested in?
How are these factors related? In what ways do they affect each other?
Why are they related? What are the dynamics that will justify the selection of factors (the "whats") and the ways that they relate to each other (the "hows")?

"What" and "how" *describe* the system in focus, while "why" *explains* it.

An attempt to follow these guidelines is made in the discussions that follow.

7.5.2 Similarities between Theory of Constraints and systems thinking

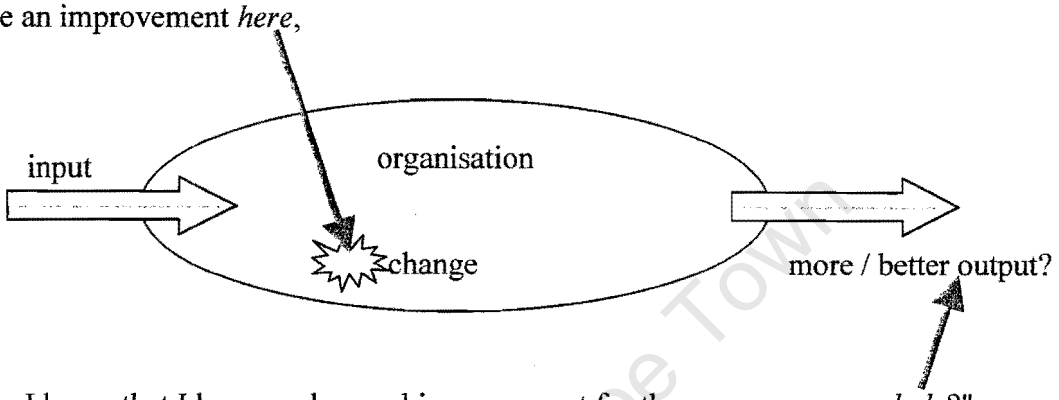
What I will try to contribute here is explain some connections that became more apparent during the action research and during reflection.

[39] David A. Whetten, *What Constitutes and Theoretical Contribution?*, Academy of Management Review, 1999, Vol. 14)

I will start by saying that Theory of Constraints (TOC) and systems thinking are on the same "wavelength". I will try to justify this by first explaining the fundamental statements made by each and then trying to note the similarities.

TOC asks...

"If I make an improvement *here*,



... how do I know that I have made a real improvement for the company *as a whole*?"

It is simplistic to think that by making an improvement (e.g. a cost saving, or waste reduction) in *any* one department in a company, that an improvement has necessarily been made in the performance of the whole company. Thinking that *any* improvement *anywhere* in the company is an improvement for the whole company is erroneous and seldom true.

Systems thinking says...

"We try to improve the parts bit by bit, but we haven't improved the *system one bit*."[40]. This is saying a similar thing to what TOC is asking. This statement means that managing and improving actions themselves, while necessary, does not ensure an improved output. The output of a system is co-produced by the *interactions* of the system's parts. TOC can be argued to provide a means to measure interactions between parts. A closer look at a TOC way of managing interactions is now shown.

[40] (Russel Ackoff, *The Ackoff Tapes*, 1991) From a description of managing systems by managing interactions.

7.5.3 TOC's *drum-buffer-rope* concept and interactions between departments

In the drum-buffer-rope application of TOC, the *buffer* may be regarded as a size measure of the amount interaction between the constraint workstation and it's predecessor. In other words a fast dropping buffer indicates fast handing over of work to the constraint. Systems thinking indicates that while the management of actions is important, the emergent properties of a system come about as a *product of the interactions*. Since DBR contains the measure of *buffer*, which is an indicator of interaction, it is a step towards managing systemically.

This is a step away from the traditional measures of efficiency and utilisation, which are measurements of *actions*, and not *interactions*. Efficiency and utilisation only have meaning when measured at the constraint, because they effectively measure the entire plant's ability to generate throughput. An efficiency or utilisation figure at a non-bottleneck station only serves to indicate to what extent the bottleneck may be "wondering" from its current position.

7.5.4 Relating Theory of Constraints to cybernetics and the Viable System Model

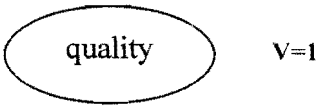
The financial background of NMP, as is the case with many companies, is based on the traditional approach of cost accounting. The argument of TOC against cost accounting is that it could lead to wrong decisions being made. However, the use of cost accounting is a strong and well-embedded feature of the context. It has become an essential *language*, and something as fundamental as a *change* in *model or language* is going to take time, and a systems thinking intervention.

If the organisation is regarded as a viable system then TOC may serve as a System 2, in other words a coordinator function. In it's coordinator function TOC it is saying "listen chaps, the press is the constraint, and everyone before it must be able to feed it, and everyone after it must be able to deal with anything it puts out".

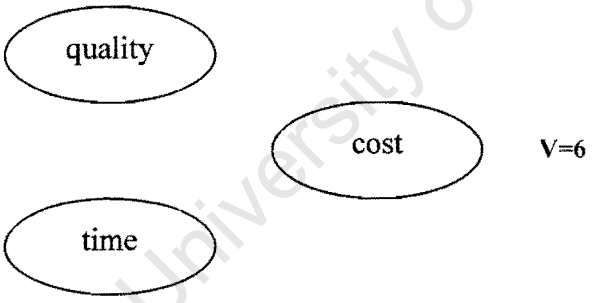
7.5.5 DBR and managing variety

From a management information point of view, there is much room for a variety overload. In terms of variety, I will try to illustrate this.

The starting problem was with quality, so I could say that the "datum" variety was equal to one, illustrated like so:

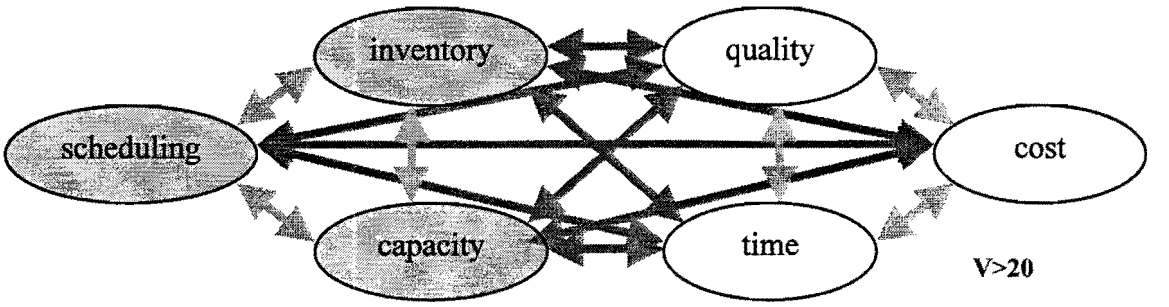


If I look at cost, quality, and time as elements of a set of MOP's, the *relative* variety would be equal to six (three elements plus three interactions). The illustration would look like so:



The above diagram shows what basis the customer judges the product on.

Meanwhile, inside the organisation, the three traditional operations issues that need to be managed are inventory, capacity, and scheduling. These are included in the model in the next illustration:



Things are looking a bit chaotic now. The (relative) variety is now many times greater than the first instance of looking at quality by itself.

Regarding the issue of managing variety, the Theory of Constraints[41] as proposed by Dr. Eliyahu Goldratt, will now be discussed. The process of adopting TOC in our company began approximately mid-1998. In particular the concepts of *drum-buffer-rope* (DBR) and *throughput accounting* were used.

The concept of DBR emerges as a result of the so-called "five focussing steps" of TOC. These are:

1. *Identify* the system's constraint
2. *Exploit* the constraint
3. *Subordinate* the rest of the system to the constraint
4. *Elevate* the constraint
5. *Go back* to step 1)

These steps may be expanded upon as follows:

[41] (Eliyahu M. Goldratt, *Goldratt Satellite Program Viewer Notebook*, 1999)

Identify the system's constraint: This is usually the bottleneck in the production line, the bottleneck being the station whose rate of production effectively determines the rate of production of the entire production chain. In TOC, the constraint must set the "beat" of production, and the rest of the production line must follow this beat. In this sense, the constraint is the *drum*.

Exploit the constraint: This means that the constraint must constantly be operating, because an hour lost on the constraint is effectively an hour lost by the entire plant. For this reason the constraint must be continually "fed" by a ready amount of work-in-progress. This WIP is the *buffer*, and the purpose of having it is to ensure that the constraint is never out of work.

Subordinate the rest of the system to the constraint: This means only allowing work into the plant if the constraint is able to accommodate it or if it will help to add to the buffer if it is looking too low. In a sense there must be a *rope* tied to the beginning of the production chain that chokes the rate of incoming work, so that pre-constraint work-in-progress does not grow without bound.

Elevate the constraint: Only now should decisions of adding capacity to the constraint area be considered. Often this is the first action that is rushed into after the constraint is identified, without first going through the steps of *exploit* and *subordinate*. If these two steps are left out, then the "hidden factory" that could be exposed in these stages would not be seen.

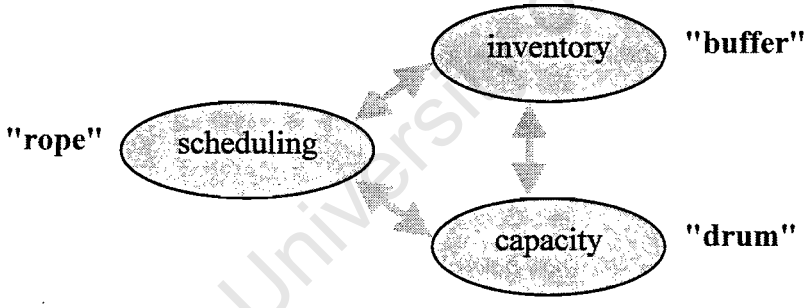
Go back to step 1): After taking steps 1) to 4), it is essential to go back and check that the constraint is still in the same place that it was defined in the previous pass. It may happen that after elevating the constraint, it now outpaces another station in the production line, and this station would now strictly be the new constraint.

Looking at the first three of the five focussing steps, the drum-buffer-rope concept can be seen. We can see that when managing inventory, capacity and scheduling, we needn't

manage inventory at *all* the machines, capacity of *all* the machines, and the scheduling of *all* the machines. TOC says that inventory need only be managed fully, or well, at *one* place, and that is just before the constraint, the *buffer*. Similarly, capacity need only be determined *at the constraint*, i.e. the constraint capacity is the *drum* that sets the beat for the rest of the plant. The speed of the rest of the plant must just be brought in line with that of the drum. Finally, the only scheduling that needs to be done is to manage the intake of work into the system to (ultimately) keep the constraint busy all of the time. This schedule would be determined by the *rope* that connects the buffer to the beginning of the production line, and chokes the release of work into manufacturing is the buffer is too high.

In this way, applying DBR principles can act as *variety attenuator* without loss of critical performance / throughput measures that are deemed to be needed to manage the system.

Knowing this, the inventory-capacity-scheduling "triangle" could be represented as such:



7.5.6 Considering purposiveness of tools and purposefulness of people

" In real-world problem solving and design, purposiveness of tools depends on purposefulness of people using tools." (Ulrich 1983)

This says that while tools can be designed with a purpose in mind, people still have to use them. People have purposes too, that may or may not be aligned with that of the tool. The daily quality sessions were supposed to be a vehicle, or a tool, for raising and addressing new problems. The extent to which this purpose "came true" is debatable. I did not consider seriously enough that *people* have to drive it, and people are goal-seeking too. This has an impact on the following section, on behaviour.

7.6 Practice

Recap on I-4c (figure 22) and rephrase: How have I improved my understanding of my behaviour? And how have I changed my behaviour?

These questions will now be addressed in the following discussions.

7.6.1 Behaviour and cybernetics principles

"The greatest problem with communication is the illusion that it has been accomplished." (George Bernard Shaw)

There was an assumption that I made at the design stage of the database where I wanted to allocate a "most likely department responsible" to each quality error that was found. In retrospect it could have been a mistake to do this. In a sense I was trying to pinpoint a source to each error; this was perhaps an example of too localised thinking. Using systems thinking, there are usually *many* causes responsible, in combination, for only *one* observable effect. From the viewpoint of management cybernetics[42], I was trying to over-attenuate the possible variety by effectively saying that the problem can only originate in *one* production department. While this is convenient from a data association point of view, this way of working should not be considered systemic, as it does not have a way to express interactions between departments.

7.6.2 Doing the right things, or just doing the wrong things righter?

Here I asked to what extent did we "do the right thing", or just carry on "doing wrong things righter". Looking at the monitoring non-conformance there could have been the fallacy of thinking that another form to fill out is going to suddenly improve the state of

[42] (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984)

affairs. In this way we may have been trying to outmuscle a problem with quality by using another checklist of sorts, in other words trying to outmuscle a quality problem with a quality "solution". Systems thinking[43] says that systems tend to resist attempts to outmuscle them. The real leverage lies elsewhere. This could have been a case of committing a "Type III" error[44].

7.6.3 Purposiveness of tools and purposefulness of people - revisit

This is a recap where I considered Churchman's[45] conditions for appreciative systems. Churchman refers to a "designer" and a "client". In designing a quality logging database and reporting system I took on the role of a designer. The people who used this system and its reports on a day to day basis were the clients. The problem in the previous section (theory) can be expressed as a mismatch between the designer's (my) value system and that of the client. I could have used a more participative approach behaviour.

7.6.4 Following problems through departments

"*What* you do isn't nearly as important as *how* what you do *affects other people*." (Russel Ackoff, *The Ackoff Tapes*, 1991, italics mine)

This quote describes the nature of systems; that results are a product of the *interactions* of a system's parts. In designing the database for logging quality inspection data I was assuming that by addressing the quality problems of each department separately, this would constitute effective action. In any case, it was not effective running between departments to get answers to quality problems. Most of the time a quality problem will be blamed on the predecessor in the supply chain.

"We are masters at pointing fingers away from ourselves". (department head)

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[43] (Peter Senge, *The Fifth Discipline*, Doubleday, 1990)
[44] See Chapter 1: What was the problem?
[45] (C.W. Churchman, *The Design of Inquiring Systems*, Basic Books, 1971)

7.6.5 Use of participative approach

What I did learn from the exercise in the previous section was to make more use of a participative approach to projects. One criticism of project teams is that the results don't "stick". Somehow *when* a project is running, the MOP's tend to look good. *After* the project finishes, the MOP's tend to drop again, and that is if they are still being measured. Having begun the gainshare development with a participative approach hopefully should maintain the buy-in and keep the associated MOP's at favourable levels after the project has run to completion and the project team dissolved.

To some extent the participative approach is a "leap of faith" because it requires one to "trust emergence".

8. Self-evaluation

Presented here is a brief self-evaluation of the thesis document on the criteria of coherence, completeness, and consistency.

Coherence - do the parts of the report "hang together"?

Attempts were made to use bridging text between sections to aid the reader. Also, use was made of a "honeycomb" design method ensure that no mismatched parts of the document were put next to each other.

Completeness - are there clear stages of introduction, main discussion, and conclusion/reflection?

The chapters are covered in these stages. However, the writer feels that the basis for some of the arguments in Chapter 4 was weak. While each of the context, theory and practice were elaborated upon, the end result was a number of discussions that could have been better connected.

Consistency - have the same ideas been used throughout?

The course is based on systems thinking and the writing should reflect this. For this reason an attempt was made to build the chapters / discussions / arguments as *systems*. This construction ensured that each chapter *did something*, explained *how* it did what it did, and *why* it did what it did.

Making use of a "honeycomb" technique for writing:

The method suggested for designing in consistency, coherence and completeness was to first prepare the first and last paragraphs of each chapter. The first paragraph ideally

answered the questions of what does the chapter do? why does it do it? and how does it do it? The last paragraph ideally presented some concluding argument.

This exercise itself was the test; if a suitable first and last chapter could be written in this way, then there was a good chance that everything inbetween also made sense. This method makes some sense with the "circular reading" principle[46], except here it is really "circular writing". It is a useful guard against the "primacy effect" and the "recency effect" in communication, that is to say, a reader will tend to remember the first thing he reads and the last thing he reads. The challenge to the writer is to get the reader to remember everything inbetween as well.

* * * * * * *

[46] Reading a long, technical document by first reading all the first paragraphs, then all the second paragraphs, and so on, filling in the gaps as you go along. Comprehension after reading a document through once in this manner is equivalent to reading the same document about 3 times through in the conventional manner. (Obviously this technique will be of little use when reading a novel.)

Appendix A: Action research report

This appendix reports on the research that took place during the thesis year (1999, February-April). It's purpose is to form a case study on which the masters thesis is based. The case study deals with the issue of quality delivery at National Magazine Printers, broadening further into the investigation of *measures of performance*[47] in general and the attitudes toward them. An action research approach was followed. What will first be shown here is a description of action research, as distinguishable from traditional research, followed by a report on the action research that was done in the organisation.

Overview of action research

This overview section draws upon the reading of Dr. Abbey Day, International Management Centers. Highlighted here are the basic principles of action research, and also how action research differs from traditional research.

Performance requires meaningful action. We may say that action is different from activity. Activity is just motion, while action is motion that has a purpose to it, and so action research projects are designed towards solving problems/improving performance.

"There is a difference between *activity* and *productivity*." (source not known)

To take effective action, relevant information is needed. To get relevant information, research needs to be done.

Research can be carried out in a so-called traditional way which may be described as being *researcher*-centered, i.e. the researcher begins with a hypothesis, gathers data to

[47] A measure of performance of a system shows to what degree the system is serving the interests of its client/s. Here, a client is anyone who can be affected by anything that the system does, and may be internal to the system (an employee in an organisation) or external to the system (a customer of the company).

test it, and reaches conclusions and makes some sort of statement of confidence about the hypothesis. After the research period is finished, often the person doing the research is left with some understanding of the system that was being studied, while the system itself is left unchanged. This is a laboratory experiment style in the sense that the system to be studied is not interfered with during the research.

Instead of traditional research, an action learning method can be used. Action learning has the joint aims of reaching some understanding the system that is being studied, *and* changing it, all during the *same* research period.

Other aspects of action learning are:

- the application to a *specific situation* (e.g. a problem in an organisation), i.e. it is an *issue*-centered approach
- the need to *involve other people* when gathering data, interpreting data, and reaching conclusions
- the *data* that is gathered helps to decide the next step in the research process
- as mentioned, the research situation demands some response *during* the research period

The following illustration shows the dual aims of action research:

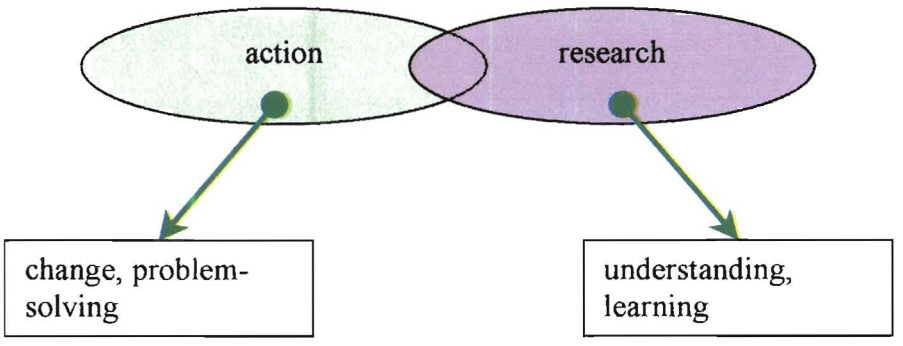

Figure 23: Aims of action research

Using the above, research styles may now be shown on a sliding scale as follows:

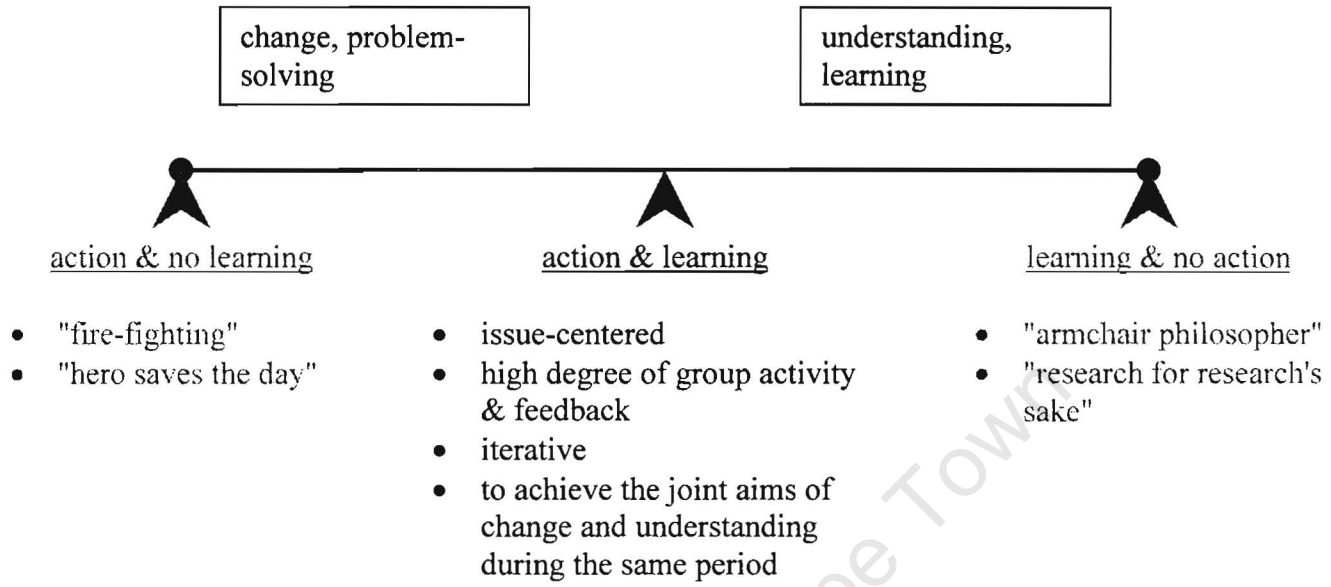

Figure 24: Sliding scale of learning styles

This ends the description of action learning, which can be summarised as an iterative research method which is focused on a certain issue in the organisation, often with group activity and feedback involved, which aims to achieve some understanding of a system while during the same time changing it.

Action research report

Shown first in this section is a description of the research framework that was followed. Following that is a short discussion on the data collection methods that were used. Then the bulk of this section, which is the research that was done in NMP, will be shown. This will be done using the framework and will amount to five iterations/cycles through the research framework.

The action research framework that was used is shown and described below:

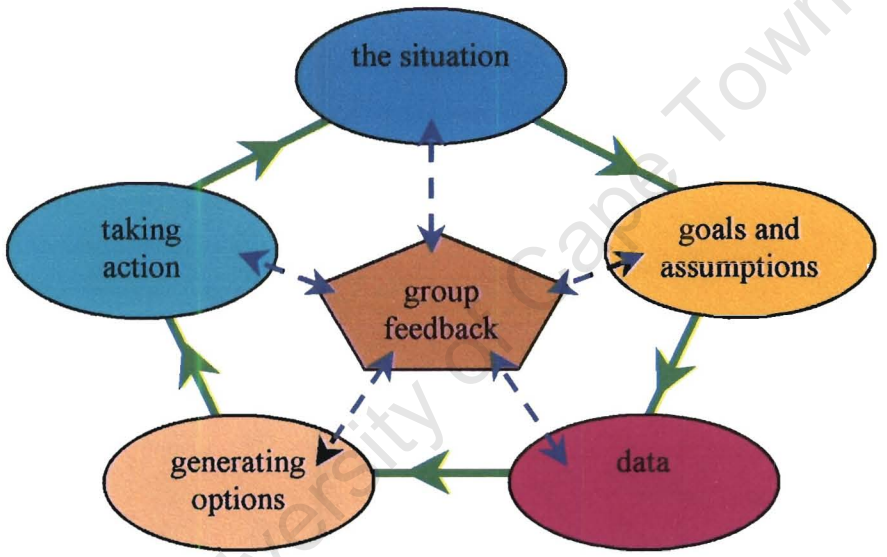

Figure 25: Stages in action research

Expanding on the above Figure 25, the stages in the action learning are:

- situation - what is the problem, or opportunity, that is looking like an issue of concern in the organisation?
- goals and assumptions - what must I try and achieve from the action research (i.e. what must change and what must be learnt), and what assumptions will I have to keep in mind?

- data - what questions should I be asking, what data will I need to collect to answer them, and what data collection methods should I use?
- generating options - what are the possible courses of action after looking at the results of the data collection?
- taking action - what option can be taken to create the necessary change and improve performance?

During the research period an attempt was made to cover all of these stages of action learning, as well as the group feedback at each stage. What follows now is a description of the stages covered during the research period, which amounts to 5 cycles. These cycles did not occur perfectly sequentially, instead there was some overlap between the end of one and the start of another. Overlaps will be made clear in the individual cycles where they occurred.

At each of the stages in Figure 25 there should be *group feedback* taking place. At National Magazine Printers there is a projects team that was set up during mid-1998 specifically for the purpose of initiating and running continuous improvement projects in the company. It consisted of a specialist from each of the areas of pre-press, press, and post-press, and other disciplines were brought on board depending on the nature of particular projects. This team was used in the group feedback at each stage covered in the action learning. This group feedback would take place along with feedback from any other current projects on a regular basis twice a week. This group acted as a support group, that is, these people were generally involved with the project, and reviewed the results from time to time and gave feedback on the various actions that were taken.

Regarding data collection, an attempt was made to use a variety of data collection methods (to try and achieve "triangulation"), covering both quantitative[48] and qualitative[49] methods.

[48] Quantitative data is numerical/statistical data, "hard numbers", for example measuring quality error frequency.
[49] Qualitative data is in the form of opinions and descriptions, for example recording an interview with a stakeholder.

The *quantitative* data was collected by two means, 1) in the form of the numerical data collected during group quality control sessions, as well as 2) a summary of other measures that had been in existence before this research was commenced. The *qualitative* data was collected by three means, 1) participant observation during group quality control sessions, 2) formal workshop sessions held with workers from the shop floor, as well as with department heads, and 3) a series of gainshare design ideas workshops with staff members. This is illustrated in the following diagram:

Figure 26: Triangulation diagram

Triangulation may be described as one level up from the use of *multiple perspectives*[50]. That is, per data collection method used in trying to achieve triangulation, there may be multiple perspectives emerging. An example was during the workshop sessions with shop floor staff, where qualitative data was gathered, there was a *personal* perspective

[50] (Harold Linestone, *Multiple Perspectives*, Systems Practice, v2 n3, 1989)

(motivation, attitude to quality) and a *technical* perspective (nature of printing, skills, machine maintenance) emerging.

The different data collection methods will be expanded upon in the cycles where they were used.

The five cycles of action learning will now be described.

Cycle1: Quality inspection

This cycle begins the research with an investigation into a quality problem. This formed part of the initial "immersion" process. This chapter centers around the issue of quality because it was the first of the performance measures that indicated a problem. It tries to show the role that product quality plays in the organisation, as well as some new attempts to measure it.

Situation:

We have a quality problem. We have seen evidence of disappointed clients, and there exists the possibility of losing clients. Now, there are obviously many other operational variables being used in the organisation that may be considered. These include paper waste, training level of staff, absenteeism, motivation levels, due date performance, job lead times, and others. However, from the point of view of the "burning platform" that we were finding ourselves on, we decided that quality should receive the first focus. In a sense we would "throw in the line" at the quality issue, and then see what patterns and leads may surface from there.

What is described now is an example of a quality problem, and the usual way of trying to "solve" it. The example came from the organisation and the usual way of trying to solve it was an indicator of what was then the current thinking that was in use.

Near the beginning of 1999 there was an instance of a quality problem where a customer's advertisement in a certain magazine was distorted because we did not print the colour to specification[51]. Our Client Services department offered to reimburse the customer with the price of the advert. The customer argued that reimbursing was not the

[51] Colour specification would typically be expressed as the % ink coverage of yellow, cyan, magenta, and black on a page/part of a page. With cosmetics, for example, the colour of the cosmetic item is it's selling point, hence it obviously has to be printed correctly in the advert.

point. The colour in the advert should have been printed properly in the first place. In any case what would compensation do? By not getting the quality right we had caused much more damage than just the price of the advert; we had in fact *harmed the customer's ability to do business*.

If customers took their business elsewhere because of this, are they unreasonable? Have they just become fussy?

Well, if a customer asks us to do a job, which we say we can do, and then we deliver something that was not done properly and which actually does damage to their business, then there is no reason why they shouldn't leave without saying another word. From this point of view, the customer would be very *un*reasonable by letting us *keep* the business!

A basic measure of how well a product does what it is supposed to do, is its *quality*. A product's quality (or other descriptions such as "reliability", or "fitness-for-purpose") is a measure of the excellence of its attributes.

In summary the situation may be expressed like so: We can say that quality contributes to what makes or breaks the relationship with the client. We can also say that "throwing money" at quality problems, that is by reimbursing the customer with credit notes, is a treatment for a symptom. At best this can quiet an unhappy customer in the short term, but the client's business can be harmed. Clients are not becoming unreasonable. Their ability to do business successfully is influenced directly by how NMP prints. For this reason they are expecting us to deliver what we said we would. For these reasons, NMP's quality methods should receive the first focus.

Goals and assumptions:

The things that we would like to achieve from this first cycle are:

- to improve quality primarily; this is the change that is required in the short term, which will give rise to less credit notes and will hopefully cause clients to stay with us in the long term
- as an offshoot of the above, to develop a way of measuring quality other than by counting customer complaints and/or adding up the value of credit notes, i.e. move from an extremely post-event reactive quality control more towards a situation of defect prevention and quality closer to the source
- to learn what measures of quality are being used in the company

One starting assumption was that we cannot continue to appease disappointed clients with credit notes. This "solution" damages the bottom line in the short term as well as our reputation in the long term. Also, we believed that the real cost was much higher than the value of the credit note, in the way of damaged value perception and lost opportunity for more work.

We need to start *measuring* quality in a new way, but the aim was not to use the information to blame a department or a person within the organisation. Instead the aim was to try to remain objective and use the information as a focusing tool, i.e. to aid in deciding what to do next. With this in mind, the data collection method and the results will now be shown.

Data:

Quality in organisations centers around the areas of:

- *quality control* (cyclic activity of inspecting the output and coming back to adjust the process) and,

- *quality assurance* (being able to make a statement of confidence to an outside party regarding the quality level, because of quality already designed into the process)

We had a choice between these two approaches. For starters, the quality *control* approach was opted for. It was deemed to be able produce usable data quicker than conducting investigations into the quality assurance processes of each department.

We began with informal quality meetings where samples of printed material were randomly drawn from the presses once a day. The persons doing the inspection included myself, the press and pre-press specialists, and the industrial engineer. This served the purposes of:

- an independent look at quality, from myself, and the industrial engineer, and
- to "throw in the line", i.e. make a start on the quality investigation and see what problems may arise/where it might lead to from there

The second point just mentioned was to try and use the action research aspect of *letting the data decide*, at least partially, what the next step in the research process should be.

To begin the inspection process, samples were taken off the press and evaluated. Specifically press sample were used for the following reasons:

- the press is the constraint[52] machine, so we can see immediately what the quality of the paper tons throughput is like
- it is relatively easy to gather samples of printed matter from the press and sit around a table and have a discussion, whereas it would be more awkward to take some form of pre-press sample[53] and discuss it with other people

[52] As per Theory of Constraints (Eli Goldratt), the constraint is the station in the production line that effectively determines the rate of production of the entire plant.
[53] A pre-press sample would be photographic material, digital information, or engraved cylinders. None of these would serve as a practical piece of work to have a quality discussion around.

- by the printing stage in the manufacturing process, the product (magazine, brochure, etc.) already has comparatively many of its quality attributes that the end product will be judged by

Samples were taken every day. Problems that were found were marked and if serious[54] the sample was taken to the most likely department responsible. This was more of a help to my own learning than to that of the pre-press and press specialist, from a technical point of view. Seeing as this inspection method was very much of a "post mortem" exercise (i.e. seeing the work on average 24 hours after the event), it was not intended to be a fix for problems *as soon as they were found.* Instead it was meant to be an indicator as to where future improvements should be targeted. While not "quality at the source" it was closer to the source than counting up the value of credit notes after poor quality was delivered to the customer.

This informal inspection process continued for some weeks during which I gained an appreciation for the more technical language used when talking about print quality and the processes on the machines. In this sense, the meeting of people served as a platform for *learning* and *creating awareness.* If this could work for me as an observer, in principle it could also work for anyone else who attended the quality sessions. From this observation we considered involving more people. What also emerged was the need to keep some sort of record of the inspection results; in other words we wanted to turn our informal system into a more formal one. One option was to develop a database in which to log the daily inspection data and which could generate reports and/or graphs.

A simple database for logging quality data was designed and put into use. The database was structured around the capturing of the following data items:

(for each sample)

- dates - sample date, inspection date

[54] What was regarded as "serious enough"? Our starting approach was that "if it is noticeable, then it is serious enough".

- production tracking data - job number, section[55] number, language code, machine number
- error information - error type, location in the work, most likely department responsible

The issue arose during the sessions as to what constitutes a significant enough quality error to log. We said that if it was noticeable then it would be recorded.

Each day a feedback report from the quality meeting was given to the operators on each press. It had a format as follows:

Daily Quality Inspection

Today's date: *Mon 30 August 1999*
Sample date **Mon** *17 May 1999* ***to:*** **Mon** *17 May 1999*

Error type	*Press 5*	*Press 6*	*Press 7*	*Press 8*
belt marks	0	1	0	0
doctor blade marks	1	0	0	0
electrostatic assist	0	0	1	0
folding inaccurate	0	1	1	0
jaw/bekkie marks	0	1	0	0
register out	0	1	0	0
scales not measured	1	0	1	0
smudge	0	1	1	0
streaking	0	1	0	0
Totals per press:	**2**	**6**	**4**	**0**
# samples evaluated:	**3**	**3**	**3**	**6**
Errors per sample:	**0.7**	**2.0**	**1.3**	**0.0**

Figure 27: Daily quality inspection report sample

[55] The whole magazine is not printed at once. It is printed in a number of parts called *sections*. The correct sections are then assembled and when bound together they will make up the whole magazine. In this sense a printing factory is a classic "A-plant", or assembly plant.

This was the format of the report that showed the results of the daily quality inspection. Each applicable error type was displayed, along with the number of times it occurred on the samples from each press. Also shown was the number of samples that was inspected from each press. Using these figures, a ratio of "number of errors per sample" was calculated. This ratio could then be used as an overall indicator of the quality being produced by a specific machine and its crew. It should be remembered that this was a quality error *frequency* indicator, and did not indicate the *severity* of quality errors. Several weeks of building up a history of data such as this allowed a trend graph to be generated, shown as follows:

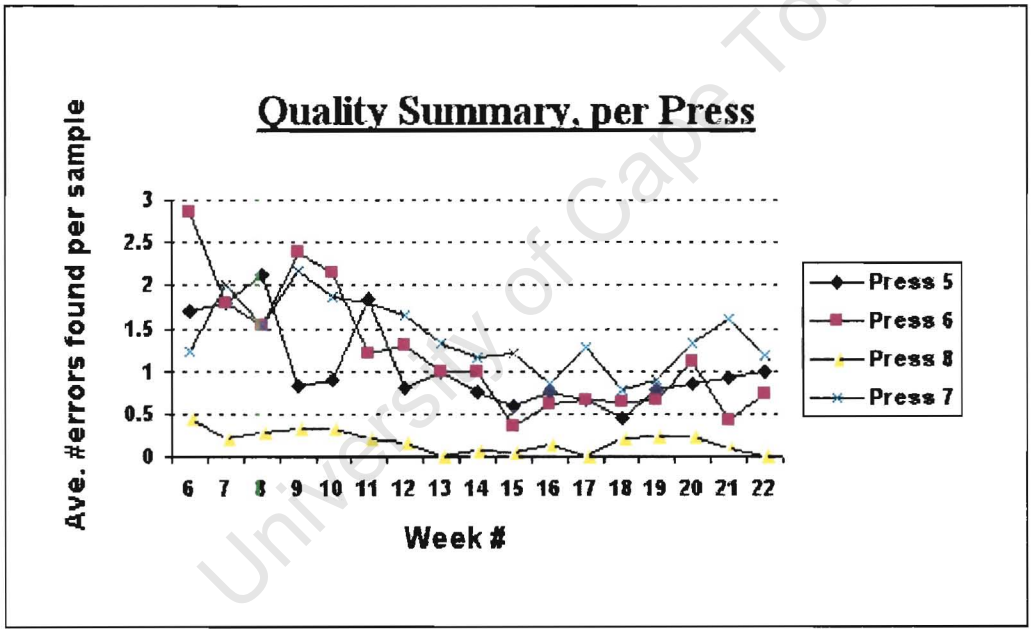

Figure 28: Quality trend graph, from week 6 to week 22[56]

The to-date version of this graph appended each daily report. This aimed to give the machine operators an indication of trends in quality level. Also, the crew from each machine was able to see the performance of each other crew. This could potentially

[56] It is worthwhile noting that while the graph ends on week#22, the actual quality meetings continued to be run on a daily basis. This is useful to note, and will be referred to, in later cycles.

generate a competitive atmosphere in the department between crews on the various presses.

The graph showed a downward trend, indicating an improvement. This was interesting, and perhaps counter-intuitive, because inspection by itself does not usually *reduce* the amount of defective material straight away, and what we were doing every morning was nothing other than basic inspection of material after a certain point in the production process. Still there was a downward trend, indicating that defective material was becoming less frequent. The apparent reason for this improvement was due to the feedback that was being given to people on the shop floor in addition to the inspection of the work.

Periodically, a ranked count on error type was calculated and added to the feedback. An example of this report, pertaining to one of the presses, follows:

Press quality errors frequency

Today: 30 August 1999

Press#	*Error type*	*Count*
5		
	register out	33
	electrostatic assist	32
	folding inaccurate	22
	streaking	20
	belt marks	8
	not matched to chrom	7
	colour difference	6
	smudge	6
	doctor blade marks	5
	ink viscosity	5
	line-up is out	5
	scales not measured	4
	tucker blade marks	3
	ink splashes	3
	whiskering	3
	scumming	3
	patchy/blotchy tone	2
	spider marks	2
	chrome coming off	1
	tension mark	1
	lack of detail	1
	folder marks	1
	impression roller	1
	ink evaporating	1
	print dropping away	1
	turner bar marks	1

Figure 29: Example of quality errors frequency report - per press

This type of report showed a familiar 80/20 trend. A re-phrasing of this in our case is to say that most of the actual quality errors found can be explained by relatively very few of the actual types of errors that there are. This provided another focusing tool.

Generating options:

At this stage in the data collection process there were a number of issues arising that influenced the options that were available. These will now be described.

- Nature of press samples and reason for taking samples:

Before we began with daily inspection, samples were already being taken from the press and stored for a three month period. This was an existing operating procedure. There would be one printed sample taken at each reel change[57], plus a sample of white (unprinted) paper. This was essentially for protection. In the case of a client making a complaint about quality after despatching, we had some proof of the overall nature of the print run that could then be used to reinforce or refute the customer's claim. This may sound strange since it should not matter what *our* proof of the print run shows, if the customer found a fault then that should be proof enough of poor quality.

At one stage there were comments that there was nothing stopping a press operator from waiting until the printed quality was good and then holding several of these good copies aside, and simply adding one of these copies to the samples on every reel change. The system could be fooled in this way and this would now seriously affect the usefulness of the data collected at the quality sessions.

It happened on some occasions that the quality of the printed matter was logged as having few/no errors, but there were serious faults found with the colour and folding when looking at the final bound product. Both colour and folding are primary press quality attributes. The immediate question arising regarding the quality meetings then was "who is fooling who?" However, further studying of this anomaly between press inspection results and post-delivery quality showed that it happened only very seldom (<5 instances

[57] There can be many paper reels that are consumed in succession to complete a print run. In this way, the number of samples kept from a print run is approximately proportional to the length of the run.

out of approximately 280 print jobs inspected over this initial research period), hence will not be seen to cause a significant distortion of quality data.

- Post press quality issues:

Naturally, quality attributes are given to a product all the way through the production line, and the further downstream that spoilage occurs, the more expensive it is because of the loss of value added up until the point of spoilage. The quality of the binding and despatch processes also plays a significant role. It was felt that a similar emphasis should be placed on the bindery quality. A next possible move would be to start looking at bindery samples as well.

- Ownership of quality:

Many times the comment was made by machine operators that for their shift they are in charge of a R20million machine and the quality being produced by it, yet they have to sign somewhere before being able to "book a new pen out of the store". This raises the question of empowerment and ownership; do operators really have the power to influence the quality of their machine?

- Monitoring of non-conformance:

There was a new focus that was initiated partly (but not totally) as an offshoot of the quality awareness generated at the quality control meetings. One of the pre-press departments began to develop a new procedure in their department around the issue of "non-conformance". Basically, if there was something being done in the department that *did not conform to a standard* then it was noted and written up on a non-conformance form. This definition of non-conformance would include quality problems if that was the case, but also any other types of problems, be they due to scheduling, maintenance, corrupted digital work coming from editorial, etc. A simple information system for the department had been built around this.

When a form was initiated, the nature of the problem was given, a possible solution, and then a name was attached to it for feedback at a later time. The aim was to get people to think twice (or three times, or even *ten* times) before just doing something blindly, out of procedure or for any other reason. The aim was *not* to use the form as a means for disciplinary action.

After some weeks of use, the department had built up a substantial knowledge base on problem-solving in their department. Now when a problem comes up, the non-conformance history is first consulted to see how similar problems were handled in the past. This history served as a focusing tool for finding solutions quicker for problems in the department.

In summary, the options were:

- to include bindery work in the inspection
- to investigate the nature of ownership and to map the link between accountability and influence
- to further investigate the idea of "non-conformance" monitoring; in principle it could be used within departments, as well as (and from a systems thinking point of view, *preferably*) between them
- to somehow derive a "rich picture" of what the attitude to quality was in the company; so far we have made some quantitative measurements of it, but what are people's *attitudes* to it

Taking action:

The action subsequent to this first pass of an action research cycle was to do three things:

- include post-press involvement in the quality meetings

- to develop a rich picture of the attitude towards quality that is held by the people at NMP - here I would need to make use of qualitative data collection methods
- to make more use of the "non-conformance" concept that was originated in one of the departments

Cycle2: Workshops on quality

Situation:

How did the situation change from the first cycle?

1) As measured in the daily sessions, the frequency of quality errors was dropping, indicating an improvement. This was not a chance to sit back on laurels; this was a chance to explore further the impact on other areas of the business and other measures of performance.

2) The non-conformance idea and the use of "non-conformance forms" was extended across production departments. This provided a way for inquiry to flow between departments.

3) Also, the attendance of an operator from each production department to the quality meetings was made mandatory. This made for extensive discussions around product quality and often the subject of discussion went well beyond that of quality, including cost, run time, waste, hand-over between departments, training, attitude to quality, motivation, and others.

During the time that the daily quality inspections were being run and results were being monitored there emerged the need to take a more qualitative look at the attitude to quality in the company, and to attempt to record or map them.

We decided to plan and hold workshops with people from the shop floor, and with the production department heads (middle management).

Goals and assumptions:

The goal of running these workshops, was to see what the attitude was to quality, as held by the workers, and as held by the production management. We wanted to see if there was any new insight or direction as to a next step that could be gained to guide the action learning process.

Our assumption was that making use of a participative method to gather data may make the process more meaningful and may yield more insight by way of surfacing multiple perspectives on the subject.

One assumption definitely was that shop floor staff are the best equipped to raise problems about production. We also assumed that the views of the production department heads and those of staff may not necessarily be the same, and that these workshop sessions would highlight differences if there were any.

Another assumption which was perhaps more subtle was that, while efforts were put in to prepare a comprehensive set of topic questions for the workshops, these questions were the "right ones to ask". The choice of questions will be explained in the following section on data.

Data:

The workshop sessions were planned with discussion groups with specific questions that were posed to the groups.

Each group of factory staff consisted of (at least) one person from each production department from repro through to despatch. There were four such groups that attended the workshop sessions and there were three sessions held over two weeks to cover each of the three (rotating) shifts. Each group had a facilitator whose function it was to encourage discussion, but not to change the actual content of the discussion.

The session with production department heads was held in a similar manner, except only one session was held, and there were no facilitators.

The questions that were posed for discussion are listed, plus an explanation for the choice of question:

- *Why is quality important*? - This is a suitable starting point, to ask if there's any point to talking about quality.
- *How do you see our current quality of our products, materials, process, information and training*? - This was asked to get a comment or opinion of quality levels. Also, materials, processes, information and training were also asked about to see to what extent quality applied only to products, or to various other areas of the business.
- *Who and what influences quality and who is responsible for quality*? - This is an ownership question.
- *Who is your supplier and who is your customer*? - This was asked to see if the notion of customer and supplier included internal customers and suppliers in the magazine production value chain, as well as the (more obvious) external ones (editorial, readers, paper suppliers, etc.)
- *What is preventing us from achieving world class quality*? - Here was an opportunity to get an idea of the undesirable effects[58] that people currently see in the organisation.
- *What are the critical issues in each department that a quality system must identify and monitor to ensure a sustainable high quality of output*? - This asks what should be put in place to try and address the undesirable effects that come from answering the previous question.

[58] (Eliyahu M. Goldratt, *Goldratt Satellite Program Viewer Notebook*, 1999) The Theory of Constraints approach to problem finding & solving begin with two questions, *what is the problem*? followed by *what to change*? The answer to first of these usually takes the form of one or more "undesirable effects" which can be seen in the system. These are really just the visible symptoms. The second question's answer then tries to look at underlying causes, which may not be as visible, or obvious.

The responses to the questions were documented. What follows now is a summary of the responses, firstly those of the workers on the factory floor, and then the department heads:

Why is quality important?

- maintain customer satisfaction
- quality determines the customer's confidence in the company and in the product
- to maintain/increase sales through positive word of mouth
- bad quality costs money/loses throughput
- good quality makes money
- quality shows pride in work and builds company image

How do you see our current quality of our products, materials, process, information and training?

- staff rated the outgoing product quality level as being between 50% and 70%, i.e. rated rather poorly
- product quality was inconsistent, i.e. we *can* produce good quality and have done so, but that good quality level is not sustainable
- information/communication was regarded as poor/inefficient
- managers/department heads and up are not in touch with what is happening on the shop floor
- there are some good ideas for quality improvement but many get lost in the time pressure to get production through
- the quality of the paper was seen as poor, paper breaks lose time on the press
- quality of work in the section store is not preserved between the section store and by the time it reaches the press
- time pressure is one reason that quality mistakes go through

Who and what influences quality and who is responsible for quality?

- supplier materials
- maintenance on machinery
- communication
- attitude, which varies between workers and between shift leaders
- yourself, as the operator of the machine - the person best able to manage quality

Who is your supplier and who is your customer?

- paper and ink suppliers
- editorial, and the ultimately the person buying the magazine from the shop
- previous and next departments
- receiver of outwork

What is preventing us from achieving world class quality?

- poor quality from suppliers (paper and ink)
- moral/unhappy staff/motivation/frustration
- time pressure/"double standards" during a run, start with quality, end with quantity
- misinformation/information not "transparent"
- training
- not using ideas from the floor, shot down because managers know "better"
- unrealistic demands from customer

What are the critical issues in each department that a quality system must identify and evaluate to ensure a sustainable high quality of output?

- trained/qualified staff
- continuous training and re-training

- training should be more focused
- multi-skilling between departments
- managers more involved on the floor and not in the office
- stay ahead of technology
- 24 hour quality control, checks and feedback
- quality *during* the process
- right paper
- better investigation of causes of problems

A similar session was held with middle management (i.e. the production department heads). The responses were as follows:

Why is quality important?

- quality is the measure that let's potential clients start to consider us as a printer of their magazines, quality is the starting point

How do you see our current quality of our products, materials, process, information and training?

- inconsistent, it seems we get some right and some wrong
- current quality of information is ok, but there could be an overload of it

Who and what influences quality and who is responsible for quality?

- the person best able to influence quality is the person on the job
- there are sometimes procedural problems that prevent or delay things from getting done, one of these things that are being affected could be quality
- suppliers of materials (paper, ink, page material from editorial) influence quality
- attitude of workers and of managers

Who is your supplier and who is your customer?

- anyone who you do work for and have to give a product to is your customer
- anyone who does work for you and gives you a product is your supplier

What is preventing us from achieving world class quality?

- no formal quality policy, system or standards
- double standards
- NMP's vision is not communicated throughout
- no alignment of quality projects
- no common understanding regarding quality
- lack of communication
- insufficient commitment to quality
- training not focused enough

What are the critical issues in each department that a quality system must identify and monitor to ensure a sustainable high quality of output?

- educated staff, continuous training on all levels
- clearly defined roles and responsibilities
- clearly defined and documented quality standards and procedures, and measurable expectation of each process
- commitment to quality
- management's attention
- quality manager and / or controller (per shift and machine)
- feedback and communication, staff's participation in making decisions and responsibility
- holistic view of interaction of all internal and external processes, understanding of cause and effect

- system of continuous improvement
- QA system which ensures consistent quality
- buy in on all levels
- customer and market orientation
- quality circles

Generating options:

Emerging from the above sessions was how broad the concept of quality was. What was also noticeable was the extent of overlap between the thoughts of the production department heads and of the shop floor workers.

Options that arose from the above data were:

- include production department heads in the quality meetings on a rotational basis
- include members from service departments related to production in the quality meetings, e.g. maintenance, health & safety, paper store
- to investigate what other measures can be listed alongside that of quality in order to show a richer picture containing a set of several measures of performance

Taking action:

Action that was taken subsequent to this pass of the action learning cycle was:

- to implement a rotational attendance of production department heads to the quality sessions, this was an attempt to add a higher profile to the issue of quality as well as to give the department head an opportunity to discuss quality issues first hand

Cycle 3: Participant observation at quality meetings

This was not a separate action learning cycle by itself. It began sometime during the quality inspection cycle and ended sometime during the workshops cycle. There was no direct options and actions that arose from this, as this cycle did not have significant contributions to make in those areas. However, the main purpose of this cycle was to build a database of quotes and opinions from the shop floor, and the qualitative data that was collected here had a purpose in supporting some of the stages in the thesis itself.

Situation:

There were rich discussions emerging from the quality meetings, and often the subject of discussion ranged well beyond that of quality. There was a meeting of multiple perspectives and the picture of quality as one of a set of many MOP's arose.

Goals and assumptions:

One of the best sources of data about the culture of a company is the "grapevine". The quality sessions were a suitable "window" into this grapevine. I decided to record the conversations that took place, with the aim of recording the rationale behind the statements and testing it with other people. While this would also be qualitative data, like what was collected in the workshop sessions, it would be collected from an informal setting as opposed to a workshop type of setting with a pre-planned set of questions and topics. The goal was to see what this new angle of qualitative data could show about the investigation up until now, and to try highlight similarities or conflicts .

Data:

The ethnographic data in this section takes the form of a library of quotes/opinions from workers and department heads, as well as from customers. These quotes/opinions came

from a variety of sources, primarily from participant observation during quality meetings, and during informal discussion with people involved with customers. During the participant observation I attempted to record the thinking behind the opinions. This was done because simply a library of quotes from the shop floor by *itself* would not serve as a useful ethnographic database.

Views from the shop floor:

"People don't grow." - There is a tendency for people to find/complain about problems, but somehow the same problems or the same state of affairs continue to exist.

"Don't worry about the quality. In this place we run for quantity, not quality." - Managers might go on about quality, but the MOP-in-focus is waste, and machine totals determine the waste, hence quantity is the overriding MOP.

"Dit is hoe dit werk in hierdie fabriek." ("This is how it works in this factory.") – Classic statement in organisations. Was this because this is the culture and for that reason only we can't do anything about it?

"Daar is te veel base. Probleme word gevind, maar die oplossings word iewers gestop." ("There are too many bosses. Problems are found, but the solutions are stopped somewhere.") – There is a variety of stages in the reporting line from shop floor to managing director level. Is this a sign of a top-heavy organisational structure?

"There is no recognition for good work. The only time you hear from them is when you mess the job up." – This looks like management by exception, only that is exceptions of bad work that get the focus.

"The name of the game around here is *brand*." ("*brand*" = "*burn*") – This is another expression of the lop-sided management by exception, focusing on the problems and not the good work.

"Dit gaan oor die stories wat jy vertel word, nie so baie oor die geld nie." ("It's got to do with the stories you get told, and not so much with the money.") – This was a comment after the zero gainshare payout from the previous gainshare system. When the new system was being developed in workshops with shop floor people one of the main things that came up was that people weren't too concerned with exactly what the gainshare payout would be calculated on. They were more concerned with not getting any surprises.

"Jy word nie betaal om te dink nie." ("You don't get paid to think.") – This is a worrying quote from the shop floor. With all the emphasis on improvement projects and creativity (espoused theory), this is still what one hears (theory in use).

"The so-called numbers one's on the presses have no power over their machine or their team. They are too little to even stop it. 'Number one' is only a name." – The press crew have control over a R20million machine for their shift, but they have to first get all sorts of permissions if they want to stop the press, do maintenance, order a spare part from the store. Does this show a mismatch between accoutability and power to use resources?

"Give me the tools and I'll do it." – People are competent and *are able* to produce outstanding work, but there is something standing in the way that is blocking this potential.

"You can't stop a machine! Are you mad?!" – This is an example of the overriding MOP of quantity, with quality falling somewhere later in the list of priorities.

"Ons moet tyd maak vir opleiding, en her-opleiding." ("We must make time for education, and re-education.") – This is especially important with the new gainshare system that was developed. People have to be well educated as to how the system works. The participative approach to developing the system in the first place is a step towards this type of understanding and buy-in of the system.

Quotes/views from customers:

"You have the best machines. Now get your people right." – A particularly biting comment from a client who is one of the fussiest about quality.

"This magazine is acceptable against the industry standard, but I'm not part of the industry. I'm above that. I'm a client." – Same client as above.

Quotes/views from department heads:

"A waste of time at the quality meetings." – This is a worrying comment. This is why the attendance of production department heads was factored into the quality sessions.

"Zero defects only applies to air-traffic control, and other operations where lives are at stake. It does not apply to National Magazine Printers." - Is this a reason then to let quality slide?

"The problem is the poor attitude, and not so much training or skill. People don't check their work, mistakes are just accepted. Seems to be no more pride in individual work now." – How did this get lost? Is this another problem that is blamed on the culture of the company, and for that reason it is assumed to have no solution?

"Mistakes are ok. This is the best we can do under the circumstances." – This is precisely what a client is not interested in hearing.

"Differences from the past; ten years ago we had very few clients and more skilled people. Now, with many clients and short runs, it's extremely difficult to get quality right quickly, for example colour on the presses." – Many clients and shorter runs is a visible trend of printed work in South Africa, and the rest of the world.

Generating options:

(not included in this cycle)

Taking action:

(not included in this cycle)

Cycle 4: Three more quantitative measures - customer complaints frequency, cost of claims, claim frequency

Situation:

There is a measure of quality and a graph that shows a trend over a period of February to June (approximately week 6 to week 22), but there is nothing to accompany it at this stage. There are several other measurements that will be shown in this cycle that were in existence before the action learning was done. These will now be graphed and compared to the results of the quality errors database.

Similar to the previous cycle, the stages on generating options and taking action were not completed. The addition of several more measures to that of quality was the intent of this cycle only.

Goals and assumptions:

The goal was to enrich the quantitative picture with other measure and we assumed that we could make the picture more complete by looking at measurements of cost of claims, claim frequency, customer complaints frequency, paper waste, and paper tons processed.

Data:

Firstly, an attempt was made here to measure the cost of quality when we get it wrong. Credit note compensation to clients for poor quality was added up per month and is shown in the graph below.

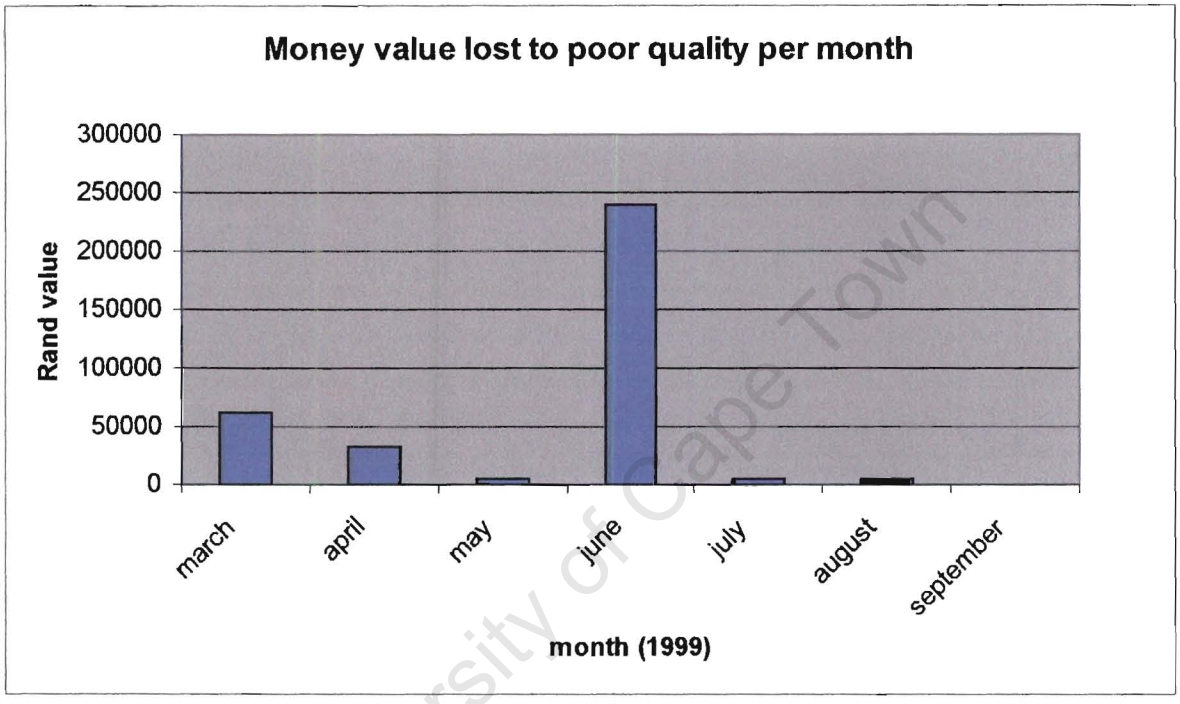

Figure 30: Cost of poor quality, Mar - Sep 1999

What is apparent is a downward trend over March to May but then a sudden jump in June. My first reaction was to think that quality must have seriously gone wrong at that time, but this can be misleading. There is a "luck of the draw" element that is creeping in here, because it depends *where* in the printed work a quality problem occurred. If, for example, a colour problem occurred in a small graphic in the corner of a page, chances are there won't be a big fuss about it from the client. If the *same* actual colour problem happened to land on a full page cosmetics advert, then there will be a significant complaint from the client which would most likely result in NMP having to reimburse the client for the advert.

So, the money value indicates the *severity* of poor quality and there is some "luck of the draw" involved in the sense of whether an instance of poor quality happened to land on an expensive advert or not. This shows that while money value lost to poor quality is *an* indicator of quality (that indicator being the severity), looking at money value *alone* is not sufficient to comment on the level of quality that is being produced. Having said that, I do not want to detract from the fact that money certainly is an important measure of performance of a business. For this reason I next looked at the claim *frequency* and customer complaint *frequency*.[59]

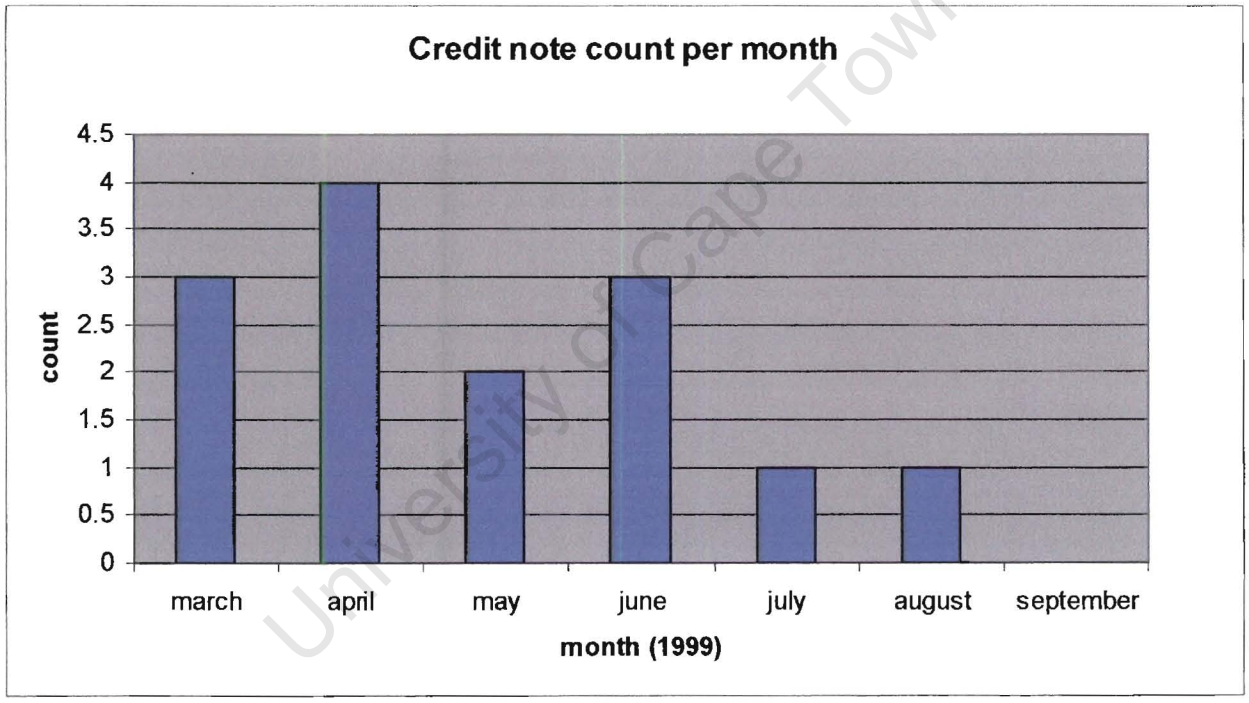

Figure 31: Credit note claim frequency, Mar - Sep 1999

[59] Here, credit note claims are distinct from customer complaints. The claims information was obtained from the normal account database of NMP's clients. The customer complaints database is a separate database which logs the complaints only (plus investigation details of the specific problem). A customer complaint may or may not develop into a claim.

This graph shows a (bumpy) decline in the *frequency* of credit note claims from March to September. This frequency may be more readily compared with the quality error frequency trend that was measured in the first action learning cycle.

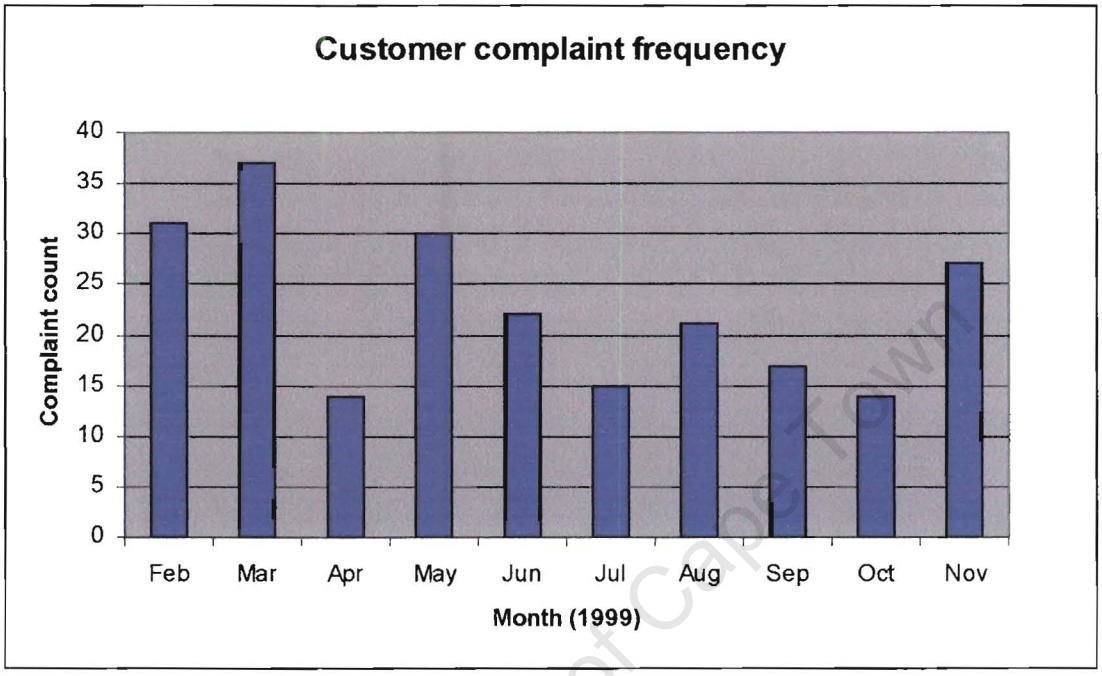

Figure 32: Customer complaints frequency, Feb - Nov 1999

The period of February to July (roughly the period of week 6 to week 22 during which quality data was logged and reported) shows another bumpy decrease in frequency of customer complaints. However, a similar leveling out as in the quality errors frequency graph is not as visible here.

Generating options:

(not included in this cycle)

Taking action:

(not included in this cycle)

Cycle 5: Participative design of a gainshare system

This is the last of the cycles covered in the action research process. It shows the participative process of designing a gainshare system for NMP. While not leading to an implementation (action) in the company during the research period, it did provide another source of qualitative information to which the thesis itself refers.

Situation

NMP may be justifiably described as a *complex system*. There are over 600 employees, 5 production (operations) departments, 6 non-production (support) departments, at least 2 active unions, etc. There are obviously a great variety of attitudes and behaviours at work. What is not obvious is what the behaviour of the whole system will be like.

I will be taking the standpoint that behaviour is *not* something that is just *there* and there's nothing that can be done about it. Rather, behaviour must have a cause (or as systems thinking suggests, it must have a *set* of causes). Hence, a description of the situation may be shown as basically a list of undesirable effects that can be observed in the organisation:

1) Unsustainable results from projects - There is a tendency for improvement projects to lose impact. Results that were obtained at the outset of a project are usually not sustained after project completion. Results are visible for the project that has the "highest profile" at any given time.

2) Awareness of the system as a whole - There is a tendency to favour local optima versus global optima. "We try to improve the parts of the system bit by bit, but we haven't improved the system *one bit*."[60]

3) Learning/continuous improvement - Problems can take a long time to be reported, and at a worst case, problems just aren't reported. This goes for improvement ideas as well, for example, an employee in the bindery came up with a creative idea and it took three months before he was recognised for it by management. This could be because when communication is taking place there are filters and/or amplifiers at work which may distort the information, and influence learning. Hampered learning is also indicated by reoccurring problems. Problems don't seem to be solved totally; they reoccur later in a different guise.

An attempt was made to achieve performance improvement by means of a gainshare system that was put in operation during mid-1998, and was run for four quarters. There was some initial interest and success with the quarterly payouts that came from this. These payouts were calculated on the operating profit for those quarters, and were based on the period-to-date's performance projected to the end of the financial year. The budgeted year-end profit was compared to the projected value and a percentage of the positive difference formed the payout, with a like amount being reserved to be paid out at the end of the financial year. This "virtual piggybank" was used as an attempt to guard against over-paying, which is one of the criteria that a gainshare system should comply to. In any event, by the third payout the calculated amount was zero, and by that stage the impact of it had been lost. For this reason this particular gainshare system was halted.

The shortcomings of this system may be described as follows:

- based on operating profit, which can arguably only be truly calculated at the end of a financial year; any quarterly calculations of operating profit are estimates only
- the payout was partially based on year-end projections; this proved extremely difficult to explain unambiguously to a factory staff of over 600 people, most of whom are paid every week

[60] (Russel Ackoff, *The Ackoff Tapes*, 1991)

Goals and assumptions

One assumption was that even though the previous gainshare system was halted, the feeling was that there should still be a gainshare system in NMP, except that it should be re-designed in a more participative manner by taking inputs from the workforce into account.

From a management cybernetics[61] point of view, what is needed is a *high variety*[62] *regulatory system* that is able to guide the *performance of the whole*. A proposed design of a new gainshare system to serve this end is now shown.

Data

This section will outline the participative process followed in designing a new gainshare system for the company. The approach considered here was to use Theory of Constraints concepts and management cybernetics. The team tackling this process included the industrial engineer and myself.

The process is summarised as follows and is then explained:

1. Gather ideas (from workshops with staff, and individually)
2. Categorise ideas (into payment calculation, payment method, payment frequency, feedback method, feedback frequency)
3. Develop criteria (for evaluating payment calculation and payment frequency)
4. Evaluate the categorised ideas using the developed criteria
5. Select the best rated idea and prepare several payment models on it

[61] Cybernetics, in the engineering sense, is the study of goal-seeking systems. There are principles in cybernetics which may be applied to organisations and their management, because organisations are goal seeking systems.

[62] Requisite variety law: The control achievable by a regulatory sub-system over a system is limited by 1) the variety of the regulator, and 2) the channel capacity between the regulator and the system. Variety is a

The first two steps listed above will now be expanded upon further in this part of the action learning cycle. The remaining three steps are described in the following section on *generating options*.

Gather ideas -

The first stage was to collect ideas for a new gainsharing system in a manner that allowed participation of the people who would be most affected by it. This is a principle suggested by Russel Ackoff[63]. The argument is that it is (systemically) not possible to plan, successfully, *for a third party*. Those affected by the plan have to be involved in the creation of it; this is a necessary first step for the sustainability of any plan

Following this importance placed on participation, there were several workshops that were held with departments. This applied to the production departments (covering all three shifts) as well as the service/admin departments. The subject of the workshops was one question,

"If there is a gainshare system at NMP, how do *you* want it to work?"

In hindsight, this was a rather different approach to the way the previous gainshare system was initiated, being something along the lines of,

"This is how the new gainshare system will work. *Do you understand*?"

We did not want to ask for a *list of all the problems with the old system* and then try to work out how to solve those problems. In a sense we "destroyed" the old system, and would now like to create a new system and list the attributes that we *want* it to have[64].

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term used to describe the number of possible states a system can exhibit. (Barry Clemson, *Cybernetics: A New Management Tool*, Abacus Press, 1984)

[63] Russel Ackoff, *The Democratic Corporation*, Oxford University Press, 1994

[64] The act of mentally destroying a system before redesigning it is an attempt to remove the assumptions and "paradigmatic baggage" that may otherwise block the creative process. (Russel Ackoff, *The Ackoff Tapes*, 1991)

Workshops ran for a period of about 5 to 6 weeks during which a "global ideas list" was drawn up.[65] For the first 3 weeks, workshops were held, and for about 3 weeks after that people were free to contribute further ideas on an individual basis.

The ideas list for this first part of the gainshare development process proved to be extensive. For this reason it is shown in a separate appendix, *Appendix B: Ideas list for gainshare system.*

Categorise ideas -

Having listed all the ideas for a new gainshare system, the next step was to try and logically group the ideas. There were five main groupings[66] that we could distinguish between, given the selection of ideas that we accumulated. These were:

- payment calculation – what is the gainshare amount based on, paper waste, tons throughput, net profit, operating profit, etc.?
- payment method – is the payout going to be in Rands, Naspers shares, food coupons, "Naspers points", etc.?
- payment frequency – how often should payouts be made during the year?
- feedback method – what should the feedback on company performance look like, should there be graphs, reports, barometers, etc.?
- feedback frequency – how often is feedback on company performance desired by the employees?

In this process some filtering did occur in the way of removing duplicate ideas[67]. As far as possible we did not change the actual content of the ideas themselves.

[65] See *Appendix B: Ideas list for gainshare system*
[66] There was a sixth category which could be called "gainshare – general", which included other suggestions, for example the formulation of a gainshare feedback committee, consisting of an organisational cross-section of members.
[67] See *Appendix C: Grouped ideas list for gainshare system*

The categorised ideas list for this second part of the gainshare development process also proved to be extensive, as it was based on the first list. It is shown in a separate appendix, *Appendix C: Grouped ideas list for gainshare system.*

Generating options

This section continues the development process by showing the development of criteria for evaluating payment calculation and payment frequency, evaluate the categorised ideas using these developed criteria, and then selecting the best rated idea and showing several payment models on it.

Develop criteria for evaluating-

We knew we would have to choose one idea above the others in the end. A way of doing this was to develop a set of criteria that we could use to rate each idea. Since the two sensitive issues, from a financial point of view, were the *payment calculation* and the *payment frequency*, a list of criteria was drawn up for each. Shown here is the criteria list for deciding on each of the payment calculation, and payment frequency.

Payment calculation,

Weight	Criteria
2	Reflect the *philosophy* and objectives of NMP (align with Theory of Constraints)
3	Reward achievement of *company-wide* performance measurements
3	Represent costs (etc) over which employees have some degree of *influence or control*
1	Set a baseline and performance *targets* that are obtainable with "stretch."
1	Reward what NMP *value* and the behaviours NMP seek.
1	Don't reward what NMP *don't value*.
3	Measure and reward that which employees can be taught or *understand*. (not complex)
2	Performance variables are *clearly identifiable*.
1	*No* upper limit
1	*Robust* against under payment (employees get less than they should) for financial year
1	*Robust* against over payment (NMP pay more than it should) for financial year
3	Potential reward sufficient to *change* attitude and behaviour (>5%)
2	*Link* between performance and reward (variability built in.)
1	*Independent* of current and future wage structure.
1	Provide frequent reward *opportunities* within the performance period
2	Ability to reward *soon* after performance period

Payment frequency,

Weight	Criteria
1	*Robust* against under payment (employees get less than they should) for financial year
2	*Robust* against over payment (NMP pay more than it should) for financial year
1	Potential reward sufficient to *change* attitude and behaviour
1	Potential to *motivate* employees on an *ongoing* basis
1	*Little time delay* between achieved performance and reward opportunity

As shown above, each criteria was given a relative weight, which was considered mainly from a financial point of view. A typical decision would be to say that when considering payment frequency, it is *more* important to make sure that the gainshare system is robust

against overpayment, than it is against underpayment, hence the higher weighting of 2 for the criteria of *robustness against overpayment*.

What may be seen here is an 80/20 "flavour" in the weighting. Of the many criteria listed, only about a quarter of them accounted for over half of the total weight sum. This is more evident in the criteria list for payment calculation, however.

These criteria were developed during a period of research, on the internet, and a literature review. Theory on gainsharing systems was revised as well as case studies from several companies.

Evaluate using criteria and select-

This step required that we first developed a list, derived from the global list, that consisted of *unique* ideas only. This was essentially a filtering step where repetitions/similarities were removed. To the best of our judgement there were no unique ideas excluded. This unique ideas list consisted of the following 8 core payment calculation methods:

Actual vs Budgeted Profit
Actual vs Budgeted Turnover
Constraint Utilisation
Different types of waste
% Of deparment savings paid to departments
Individual merit appraisal
Tonnage
Actual cumulative throughput % against required % for the financial period

A similar exercise was done for the payment frequency, and ended up being simpler. The payment frequency options were:

Weekly
Monthly
Quarterly
Every six Months
Yearly

Using the criteria developed for rating the payment calculation and the payment frequency, plus the inclusion of a weighting system to the criteria, the following results were obtained.

For payment calculation evaluation,

	Options	Rank
A	Actual vs Budgeted Profit	5
B	Actual vs Budgeted Turnover	6
C	Constraint Utilisation	2
D	Different types of waste	3
E	% Of deparment savings paid to departments	8
F	Individual merit appraisal	7
G	Paper tonnage	4
H	Actual cumulative throughput % against required % for the financial period	1

The best rated option, according to our criteria, was to base the payout calculation on actual throughput achieved, against what was required for the financial period. *Throughput* here has the meaning in the Theory of Constraints sense, which is roughly equivalent to *contribution* in traditional cost accounting terms.

For payment frequency evaluation,

	Options	Rank
A	Weekly	5
B	Monthly	1
C	Quarterly	4
D	Every six Months	3
E	Yearly	2

The monthly payout frequency came out as the best rated. The trade-off was that more frequent payments would maintain awareness, but would result in more "dilution" of the payment amount. On the other hand, a less frequent payment would result in a larger payment amount, but the long times inbetween payments could result in the loss of interest in the gainshare system.

Aside from the actual payment frequency, there was also the frequency of *feedback of company performance information* to the shop floor. This could be made (and should be made) very frequent; even much more frequent than the actual payouts. This would aid in maintaining interest in the performance of the business.

Taking action

This stage of taking action based on the options was not reached during the period covered in this action research report, and hence this section will be speculation only. What will be discussed here is the proposed gainshare system, and what the possible advantages and shortcomings of its implementation may be. An attempt will be made use Theory of Constraints thinking and management cybernetics as a basis for discussion.

To recap, the evaluation in the previous section showed that a gainshare system based on actual *throughput* against required throughput should be designed, and that the payouts should be *monthly*.

According to Theory of Constraints, the throughput (or contribution) is calculated according to,

(throughput) = (revenue) - (directly variable costs)

The revenue for work is an easily available figure. The directly variable costs still need to be split up further, but before doing this, a short explanation of what is meant by a directly variable cost, or DVC, will be given.

The Theory of Constraints definition of DVC's is *those costs that vary on a one-to-one basis with the volume of product that is produced.* That is to say, if we print one extra magazine, then we use correspondingly more:

- *paper*,
- *ink*, and
- *outwork* (if it was required to send work out)

This is the split of directly variable costs that NMP uses currently. Of course there are other direct material costs, for example binding glue, or binding staples, and others. The argument here is that paper, ink and outwork account for >80% of the direct material costs, and hence we will only target these.

Alternative expression of the definition of throughput is to say that,

(throughput) = (revenue) - (only those costs that are directly *assignable to products*)

Immediately this poses some interesting questions about such costs as overheads, which include rent, water, electricity, labour, etc. According to TOC, these are *not* directly assignable to products, and hence to speak of "product profit" as actually a misleading

language to use. This even suggests that traditional *cost accounting is a misleading language*. The closest would be to talk about "product throughput", or "product contribution". The argument against using product profit, is that when we try to assign costs such as overheads to products, we then calculate a "product profit", and *then proceed to use this product profit figure to make decisions as to which products to keep producing and which to stop producing*. The assignment of overhead costs to products is regarded as being a laborious process and almost totally arbitrary, and after doing this exercise we use it to make decisions that directly affect the immediate viability of the company.

TOC suggests that the overheads and/or costs that are *not* directly assignable to products simply be left unassigned. Decisions as to which product lines to continue and which to stop are then based on the product *throughput*, not the product profit. All the throughput amounts from the sale of products are then added up and must be compared to the overhead costs for the relevant financial period, and *then* the company can speak of a profit or a loss. This is another interesting aspect of the language of TOC; *companies* have profit, not *products*. This has a hint of a systemic basis to the measurements, as it is trying to show what the effects of the manufacturing of products can have on the performance of the *system*, i.e. the company as a whole.

At the risk of labouring the issue, there is yet another expression of the throughput formula that may be used,

(throughput) = (revenue) - (only those costs that we have direct control over)

In the case of NMP, the costs of paper, ink and outwork can be controlled directly and can be influenced in the short term. Labour cost and electricity, for example, cannot be changed in the short term, and hence should not be included in the throughput calculation.

Some background: During 1998 National Magazine Printers already began moving from a cost accounting "language" to one of throughput accounting. In other words an attempt was made to make TOC the dominant philosophy. Products were prioritised according to the rate at which they would generate contribution (throughput), and no longer according to the notion of "product profit". The constraint in the production line was defined (in our case it was defined as the *press*) and a product pricing/quoting model based on Theory of Constraints was developed and put in place.

In order to calculate payouts the evaluation and selection section previous to this showed that a calculation along the lines of the following should be made:

(payout value) = {(actual throughput achieved) - (required throughput)} x (factor)

This formula obviously applies to the work done during relevant periods, being the periods between payouts.

The *required throughput* should be calculated as,

(required throughput) = (estimated revenue) - (estimated paper cost) - (estimated ink cost) - (estimated outwork cost)

The *actual throughput achieved* should be calculated as,

(actual throughput achieved) = (actual revenue) - (actual paper cost) - (actual ink cost) - (actual outwork cost) - (correction for credit notes)

The inclusion of credit notes in the calculation for actual throughput is suggested as a measure of quality. Without it, it would still be very possible to exceed the required throughput, but at the expense of quality. This could result in claims from the client, and if these should occur, then it should count negatively towards the payout amount. Note

that including this measure of quality in the calculation has not violated the definition of DVC's in the sense that cost of quality is still *directly assignable to products.*

Bearing the specifics of the measurement as it was explained here in mind, the following production/operational issues should be targeted as a result, if this type of measurement system were to be put in place:

- paper waste reduction- awareness of this, and if paper waste is reduced, will have a direct impact via the paper cost quantity
- paper storage & handling - better storage and movement of paper would lead to less waste due to damage ("white waste"), and would impact the gainshare amount via the paper cost quantity
- ink storage - better storage and treatment of ink to reduce losses due to shelf life and chemical treatment of ink
- maintenance of machines - throughput can only be generated sustainably on well-maintained machines
- outwork prevention - if outwork (particularly binding outwork, which has been alarmingly high) can be avoided and be done in-house, then there can be a benefit, better still, if *planned* outwork can actually be done in-house due to working smarter, then a significant saving may be made
- production planning - un-optimised planning of the constraint can lead to the press plan not being met, and resulting outwork, or having to air-freight products out to make delivery dates
- product quality - prevention of claims from clients can have a direct impact via the adjustment due to credit notes
- material reception and pre-press buffer management - a well-maintained buffer before the press and repro material being delivered on time will help prevent lifting of jobs on the press and the associated increase in paper waste and possibility of outwork

The intention here is not to paint an overly "rosy" looking picture here with this proposed gainshare scheme. There are some potential drawbacks:

- based on a new measurement "language" - since beginning the shift to throughput accounting middle of 1998 there is still evidence of the TOC philosophy not being fully in use and being accepted by people
- complicated calculation of the gainshare amount - even though basing the payout on a profit measure would have involved even more complicated formulae and assumptions, the payout calculation is still quite complex from the point of view of getting everyone in the organisation to understand and buy in
- based on TOC - therefore assume that *all* work goes through the constraint; how would non-constraint in-sourced work be treated, both by the gainshare system and by the people who are going to be measured by it?

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Appendix B: Ideas list for gainshare system

Shown here is the unmodified list of ideas that flowed from the workshops for the redesign of the gainshare system at NMP.

Ideas list

Graphical depictions are meaningless. Savings must be shown in Rands and Cents.

Also shown must be where and on what the savings were made. What happens when vandalism takes place? What measures are there to show savings when items are procured locally or in-house. In other words all savings in production must be brought into the calculation.

The medium of payouts:
Give coupons for food to the value of the bonus, minus tax. When the coupons are used then effectively payment will take place. Or the company could by the food and worker could get a greater part of their bonus.

Payout to be calculated on actual profit and not projected profit. This will guarantee payouts. **Payouts to be in full and not half with half to come.**

Payouts at a fixed percentage 3 monthly with an adjustment payout at the end of the financial year when final profits are approved.

Payouts to be separate to wages . (Either by cheque or cash.)

Educate employees on exactly how the scheme works. **(Everyone must understand.)**

Elected Committee comprising of staff members (no union involvement) in conjunction with management to be formed. This will lead to better communication. **All decisions to be made by Committee and not unilaterally by management.**

Committee to have clear guidelines and policy in writing for all to see.

Committee members to be well publicised so that everyone knows exactly how the committee is comprised and what their portfolios are.

Minutes of all Committee meetings and report back meetings to be published on notice boards.

Report back on performance of company on a monthly basis by way of information meetings. **(Notice boards cannot be asked questions.)**

Barometer or graph on notice boards and electronic boards indicating target and progress. **(No moving of the set target/goalposts.)**

Provide a graph at +/- 4 months intervals that will display the profits for the previous months.

Once a year, after all deductions/taxes and whatever is calculated, a profit bonus will be paid to all.

All documented savings by departments on various purchases to be displayed, and a percentage of that to be paid to the appropriate department.

Other general suggestions:

Set an annual target, turnover or profit. Divide into 12 months of the year. Determine the production pattern over that year, according to work load/performance. If that target is exceeded by 1% then part of that so-called surplus gets displayed monthly. After 3 months the average performance will be paid out at an agreed ratio. Company/workers %/%. Any targets not reached will affect the targets reached already, adversely.

Determine hourly rates for your constraint machines. Evaluate these rates monthly. Consider that these rates are in the end based on a variety of overheads. E.g. equipment cost, rental cost, services costs, material cost, utilisation of equipment and many others.

Any improvement to any of these overheads will end up reducing the hourly rates.

To mention some of these improvements:

- Paper waste, down time, running speed, paper breaks, waiting time, material waste, component costs, etc.
- By simple displays of these measures on the notice boards. E.g. by means of barometer-type displays, where the present norms and below-performance is marked in red, and if the norms are exceeded, then they will be displayed in green.
- By this method everyone can see at a glance what we are doing right or wrong, and where our main efforts should be concentrated. These norms and targets will constantly have to be revised and updated. As long as they remain obtainable.
- As your constraint machines determine the beat of our production, the rest of our production will have to adjust to keep up with the demand. This will make us more competitive, which should benefit our order books.
- The gain-share bonus can be based on the improved hourly rates, or even the budgeted turnover.
- The bonus could be calculated on the above measures. Payout intervals should not be too far apart. Possibly every three months.
- Monetary payouts should be made to all employees, but should be made according to different income groups, so that the benefits are more realistic to the person's basic

earning. Alternatively the after-tax payout should be the same to all. Giving the highest earners the lowest after-tax bonus is not acceptable.

- Payouts must be monthly
- Payouts must be based on actual performance against planned, for that month
- Company's performance trend updated and shown on a monthly basis, as well as the reason for the performance (be it good or bad), and goals must be set on what to focus on for the next month
- "Performance" can be a set of indicators, traffic lights, barometer, whatever, but it must be simple, visual, and "fool-proof"
- Payout can be in Naspers shares, food coupons, and other ways that lessen the tax impact

- Unanimous that there should be a gain-share system.
- Must work on actuals.
- Would like 2 to 3 monthly visible feedback as to how we are doing.
- Recording of reasons why we are not making targets.
- Can food coupons be handed out in place of money? This lessens tax impact. (International Harbour Services do this).
- Generally a yearly major payout was the first choice.
- Some asked about a monthly payout as is allegedly done at Paarl Post.
- Using money to pay accounts.
- Units trusts.
- Paying into pension schemes/provident funds.
- There was a positive response from the workforce regarding management's commitment to a gain share.

- Payout every six months on a actual figure not a projected figure.
- Not on a tonnage target.
- What happens if there is no work?
- Use part of payout as tax on 13th cheque.
- What system and targets would management go for?

Should be generated from:

Tons of paper through the press

Paper waste under 7%

High production achievements

Sustain quality standards as required

No shortages per month

No rework per month.

Reduction in planned outsource work per month

No despatch failures per month.

No inferior quality per month

No major lost time per month (set target)

Staff should be informed of achievements:

- Explain all gains: what, when, why, how, how much?
- Explain all losses: what, when, why, how, how much?
- Explain rand value for all gains

  Net sum

  Per individual.

Monthly statement:

Pie chart: Illustrate percentages of revenue

- Percentage for income
- Percentage for company profit
- Percentage for gain share

Percentage for gain share:

- Monthly statement of monthly achievement in wage packet
- Monthly earnings should not be touched
- In the event of major losses in a month, the damages should be recovered from the next month(s)
- Previous earnings should not be touched
- All calculations should be done per individual month
- Monthly statements should also be displayed on the notice boards

Pay out:

Should be done in the first week of January

Separate wage packet

Separate tax deductions

Annual (summary) statement of all earnings

Determine productivity of the individual departments, in this way each department receives their own performance bonus.

One payout at the end of the book year.

Payout based on merit appraisal (individual).

One payout at end of year

If payout can work in such a way that your annual bonus could be paid out tax free and the tax could be deducted.

People feel that if they make profit on 10 jobs and have mistakes on the next ten the money must not subtracted with the jobs they were successful with.

In addition to an equal gain share for everyone, there can be a points system where individual performance can be rewarded, e.g. build up points if no sick leave taken, etc.

Monthly payouts

Actual profits not projected

100% payout

Pay like wages a month after actual profit

Payouts into a unit trust fund

Payouts 4 times a year

Visual show-case

My proposal is to maintain a payout at least every 3 months, preferably every month. This is the only way to ensure it has the desired impact. Otherwise it just becomes a 13th cheque. We must just ensure that we :

- improve on our communication as to how the thing works.
- improve our method by incorporating depreciation into the rest of the year
- allow for the seasonal impact.

This will produce the most affective system.

- 3-monthly bonus payout
- monthly feedback on performance of the company visible to all
- payout should be calculated on throughput, i.e. by comparing estimated throughput for the month to actual throughput achieved

The feedback method must cover all the levels of education in the factory. Can use %'s and graphs on one end, and should use simple models with building blocks/whatever else to give feedback to illiterate/innumerate people as well.

1. Trying to do contingency planning by keeping percentages of excesses does not work. Scrap that idea from the new system.
2. One gainshare payout at the end of the financial year. Any losses incurred (due to labour instability, outwork, volatile markets) during the year will be absorbed and one true figure will be paid out at the end of the year. This will eliminate false accusations of management having hidden agendas.

In principle they suggested the following:

- People do not understand the scoreboard that is used presently
- Electronic boards should be used to keep employees informed
- If there is a split, the split should be 25/75
- If a split is applied, a very simple barometer need to be displayed indicating the following
  - monthly balance of the amount to be expected at end of quarter
  - monthly balance of the split which is accumulated until the end of the financial year.
  - (should a month be negative, it should be displayed that the accumulated "kitty" was reduced to cover the shortfall in that particular month)
  - If that is done, the "kitty" creates an expectation. If it does not materialize, the whole effect of the gain sharing is lost due to negativeness amongst staff.
- If by means possible, the bonus must be calculated on actual materialised throughput. The cyclic nature of the industry leads to a situation where forecasts may not be very accurate, leading to surprises
- In addition to the formal gain sharing system an internal competition should be run between departments. The criteria should be very clear, i.e.
  - man-days without any injury
  - attendance
  - Cleaning and organising
  - quality defects

- quality of service etc

The winning department must get recognition in line of a function or something similar.

The competition should however be run on a monthly basis. Monthly winners goes through to the final round.

Employees should have a significant part of their compensation based directly on productivity.
Incentive systems/schemes should be designed around groups, not individuals.
Base salaries are low, but productivity bonuses can increase total compensation.
Set the standards: Goals should be attainable. (don't fear if workers beat standards – consistently – the productivity increases and is competitively advantageous)
The gainshare program should be easily understood. Problems arise when it becomes too complicated.
The rewards should be received rapidly.
The time periods between payouts should be shortened, e.g. fortnightly/weekly
If you work hard you receive the benefit = best kind of conditioning. In this manner employees can tie increased effort and productivity directly to increased reward and compensation.
Operations should be definable and measurable with regular checks made.
When setting standards, management should involve the employee. Employees (ground level) should become involved with the day to day drawing up of this new gainshare system and also when compensations are paid.
All this will lead to improvement in management-employee relations.

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Appendix C: Grouped ideas list for gainshare system

The ideas in the list in Appendix B were grouped into the categories of:

1. general
2. payment method
3. payment frequency
4. payment calculation
5. feedback method
6. feedback frequency

These will now be expanded upon.

1. Gainshare system - general

Unanimous "YES" that there should be a gain-share system.

There was a positive response from the workforce regarding management's commitment to a gain share.

What system and targets would management go for?

Change RPM name, RPM has lost its credibility amongst staff. "NMP staff incentive scheme" or something in that line.

Educate employees on exactly how the scheme works. **(Everyone must understand.)**

Elected Committee comprising of staff members (no union involvement) in conjunction with management to be formed. This will lead to better communication. **All decisions to be made by Committee and not unilaterally by management.**

Committee to have clear guidelines and policy in writing for all to see.
Committee members to be well publicised so that everyone knows exactly how the committee is comprised and what their portfolios are.

People feel that if they make profit on 10 jobs and have problems on the next ten **the money must not subtracted** with the jobs they were successful with.
In addition to an equal gain share for everyone, there can be a points system where individual performance can be rewarded, e.g. build up points if no sick leave taken, etc.

Trying to do contingency planning by keeping percentages of excesses does not work. Scrap that idea from the new system.

People do not understand the scoreboard that is used presently
Electronic boards should be used to keep employees informed
If there is a split, the split should be 25/75
If a split is applied, a very simple barometer need to be displayed indicating the following
monthly balance of the amount to be expected at end of quarter
monthly balance of the split which is accumulated until the end of the financial year.
(should a month be negative, it should be displayed that the accumulated "kitty" was reduced to cover the shortfall in that particular month)
If that is done, the "kitty" creates an expectation. If it does not materialize, the whole effect of the gain sharing is lost due to negativeness amongst staff.
If by means possible, the bonus must be calculated on actual materialised throughput.
The cyclic nature of the industry leads to a situation where forecasts may not be very accurate, leading to surprises
In addition to the formal gain sharing system an internal competition should be run between departments. The criteria should be very clear, i.e.
man-days without any injury

- attendance
- cleaning and organising
- quality defects

- quality of service etc

The winning department must get recognition in line of a function or something similar.

The competition should however be run on a monthly basis. Monthly winners goes through to the final round.

Employees should have a significant part of their compensation based directly on productivity.
Incentive systems/schemes should be designed around groups, not individuals.
Base salaries are low, but productivity bonuses can increase total compensation.
Set the standards: Goals should be attainable. (don't fear if workers beat standards – consistently – the productivity increases and is competitively advantageous)
The gainshare program should be easily understood. Problems arise when it becomes too complicated.
If you work hard you receive the benefit = best kind of conditioning. In this manner employees can tie increased effort and productivity directly to increased reward and compensation.
Operations should be definable and measurable with regular checks made.
When setting standards, management should involve the employee. Employees (ground level) should become involved with the day to day drawing up of this new gainshare system and also when compensations are paid.

2. Payment method

Coupons: Give coupons for food to the value of the bonus, minus tax. When the coupons are used then effectively payment will take place. Or the company could by the food and worker could get a greater part of their bonus.

Payouts to be separate to wages . (Either by cheque or cash.)

Payout can be in Naspers shares, food coupons, and other ways that lessen the tax impact (International Harbour Services do this).

Using money to pay accounts.

Units trusts.

Paying into pension schemes/provident funds.

Use part of payout as tax on 13th cheque.

Separate from wage packet

Separate tax deductions

Actual **profits not projected**

100% payout

Pay like wages a month after actual profit

Payouts into a unit trust fund

Payout should be calculated on throughput, i.e. by comparing estimated throughput for the month to actual throughput achieved

3. Payment frequency

Payouts at a fixed percentage 3 monthly with an adjustment payout at the end of the financial year when final profits are approved.

Payouts must be monthly as is allegedly done at Paarl Post.

Generally a yearly major payout was the first choice.

Payout every six months on a actual figure not a projected figure.

Pay out:

should be done in the first week of January

Yearly at end of financial year

My proposal is to maintain a payout at least every 3 months, preferably every month. This is the only way to ensure it has the desired impact. Otherwise it just becomes a 13th cheque. We must just ensure that we :

- improve on our communication as to how the thing works.
- improve our method by incorporating depreciation into the rest of the year

allow for the seasonal impact.

One gainshare payout at the end of the financial year. Any losses incurred (due to labour instability, outwork, volatile markets) during the year will be absorbed and one true figure will be paid out at the end of the year. This will eliminate false accusations of management having hidden agendas.

The rewards should be received rapidly. The time periods between payouts should be shortened, e.g. fortnightly/weekly

4. Payment calculation

Payout to be calculated on actual profit and not projected profit. This will guarantee payouts. **Payouts to be in full and not half with half to come.**

Set an annual target, turnover or profit. Divide into 12 months of the year. Determine the production pattern over that year, according to work load/performance. If that target

is exceeded by 1% then part of that so-called surplus gets displayed monthly. After 3 months the average performance will be paid out at an agreed ratio. Company/workers %. Any targets not reached will affect the targets reached already, adversely.

Determine hourly rates for your constraint machines. Evaluate these rates monthly. Consider that these rates are in the end based on a variety of overheads. E.g. equipment cost, rental cost, services costs, material cost, utilisation of equipment and many others. As your constraint machines determine the beat of our production, the rest of our production will have to adjust to keep up with the demand. This will make us more competitive, which should benefit our order books.

The bonus could be calculated on different types of waste such as the paper waste, down time, running speed, paper breaks, waiting time, material waste, component costs, etc.

Monetary payouts should be made to all employees, but should be made according to different income groups, so that the benefits are more realistic to the person's basic earning. Alternatively the after-tax payout should be the same to all. Giving the highest earners the lowest after-tax bonus is not acceptable.

Percentage of departments savings paid to department.

Payout based on merit appraisal (individual).

The gain-share bonus can be based on the improved hourly rates, or even the budgeted turnover.

Payouts must be based on actual performance against planned, for that month

Not calculated on a tonnage target. What happens if there is no work? Must work on actuals.

Should be calculated from:
Tons of paper through the press
Paper waste under 7%
High production achievements
Sustain quality standards as required
No shortages per month
No rework per month.
Reduction in planned outsource work per month
No despatch failures per month.
No inferior quality per month
No major lost time per month (set target)

Monthly earnings should not be touched

In the event of major losses in a month, the damages should be recovered from the next month(s)

Previous earnings should not be touched

All calculations should be done per individual month

5. Feedback method

Not graphical - percentages

Show monetary amounts

Source of savings

What, why when, how. What happens when vandalism takes place? What measures are there to show savings when items are procured locally or in-house. In other words all savings in production must be brought into the calculation.

Minutes of all Committee meetings and report back meetings to be published on notice boards.

Report back on performance of company on a monthly basis by way of information meetings. **(Notice boards cannot be asked questions.)**

Barometer or graph on notice boards and electronic boards indicating target and progress. **(No moving of the set target/goalposts.)**

Recording of reasons why we are not making targets.

Provide a graph at +/- 4 months intervals that will display the profits for the previous months.

All documented savings by departments on various purchases to be displayed, and a percentage of that to be paid to the appropriate department.

By simple displays of these measures on the notice boards. E.g. by means of barometer-type displays, where the present norms and below-performance is marked in red, and if the norms are exceeded, then they will be displayed in green. By this method everyone can see at a glance what we are doing right or wrong, and where our main efforts should be concentrated. These norms and targets will constantly have to be revised and updated. As long as they remain obtainable.

The feedback method must cover all the levels of education in the factory. Can use %'s and graphs on one end, and should use simple models with building blocks/whatever else to give feedback to illiterate/innumerate people as well.

6. Feedback frequency

+/- 4 months intervals

Once a year, after all deductions/taxes and whatever is calculated, a profit bonus will be paid to all.

Monthly display of performance

Feedback intervals should not be too far apart. Possibly every three months.

Company's performance trend updated and shown on a monthly basis, as well as the reason for the performance (be it good or bad), and goals must be set on what to focus on for the next month

"Performance" can be a set of indicators, traffic lights, barometer, whatever, but it must be simple, visual, and idiot-proof

Would like 2 to 3 monthly visible feedback as to how we are doing.
Monthly statement:

Pie chart: Illustrate percentages of revenue

Percentage for income

Percentage for company profit

Percentage for gain share

Percentage for gain share:

Monthly statement of monthly achievement in wage packet

Monthly statements should also be displayed on the notice boards

Annual (summary) statement of all earnings

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