

**THE DEVELOPMENT OF A METHODOLOGY FOR THE COST  
JUSTIFICATION OF NEW MANUFACTURING INVESTMENTS**

**Volume I**

by

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# **The Development of a Methodology for the Cost Justification of New Manufacturing Investments**

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## **Abstract**

This work addresses the problems faced by small and medium manufacturing enterprises (SME's) in cost justifying new investments in tools, techniques and technologies, and presents a methodology which significantly improves on current cost justification techniques. The methodology provides a structured approach which leads a company through a series of workshops, which assist a company in establishing the full company wide benefits and costs associated with new manufacturing investment. A model, in the form of a workbook and the specification for a prototype computer based tool, of the tasks necessary in cost justification is presented. The model is used to structure the decisions relating to possible investments.

The research work described involved two distinct stages. The first stage included a fifteen month involvement in the Finjust project - a financial justification project sponsored by the DTI, in collaboration with Quintec Applied Systems, Mundy Johnson, Entrepreneurial Technologies and the University of Plymouth, where the author's individual contribution was for the identification of the links between business needs and technologies and specifying the benefits of the investments. The author's involvement in the project allowed the strategy to be tested in the collaborating companies.

In the second stage, the major contribution of the research lies in the development of a new methodology, which whilst based on some of the principles of the Finjust project, incorporates many new ideas which significantly improve its value to SME's.

Through the use of this work SME's are encouraged to improve ownership and commitment to the manufacturing solutions identified by fully involving relevant company personnel in the identification of business needs, the generation of solutions and the financial justification of proposed investments. This work also provides a mechanism to facilitate management development and training in financial justification by providing rationales for each activity, forms for the collection of data and tool kits to assist in the completion of specific tasks.

The results of this work have provided the data necessary for the specification and building of an improved methodology in the form of a workbook.

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## **AUTHOR'S DECLARATION**

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award.

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Relevant manufacturing conferences were attended at which several papers were presented:

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"Development of a Methodology to Assist SME's to Identify CIM Technologies for Specific Business Performance Improvement Requirements." Povl Larsen and Prof. David Hughes. The Eighth World Productivity Congress, Stockholm, Sweden. 1993 May

"CBT - On Screen Simplicity, Hides Off Screen Complexity". Povl Larsen and Prof. David Hughes. The XXIX Annual International Conference of the Association for Education & Training Technology. Edinburgh, Scotland. 1994 April.

"PROFIT - Program for Financing Investments in Technology". Povl Larsen and Prof. David Hughes. Factory 2000, York, England. 1994.

Also, external companies and Government Departments were visited for consultation purposes, including:

Quintec Applied Systems, Oxford; Mundy Johnson Consultants, Reading; Entrepreneurial Technologies, Cornwall and the Department of Trade and Industry, London.

Signed: Povl Larsen

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## Abbreviations and Acronyms

ABC	Activity Based Costing.
Act	Actual.
AGV	Automated Guided Vehicle.
AMT	Advanced Manufacturing Technologies.
AMTTT	Advanced Manufacturing Tools, Techniques and Technologies.
AT	Asset Turnover.
ATE	Automatic Test Equipment.
BCR	Benefit Cost Ratio.
BE(£)	Break Even Analysis for monetary value.
BE(Units)	Break Even Analysis for number of units.
BEA	Break Even Analysis.
BEAG	Break Even Analysis Graphical.
BN	Business Need(s).
BOP	Bought Out Parts.
CAD	Computer Aided Design.
CADCAM	Computer Aided Design with Computer Aided Manufacture.
CAPM	Computer Aided Production Management.
CAPP	Computer Aided Process Planning.
CAT	Corrective Action Teams.
CB	Cash Budgets.
CBA	Cost Benefit Analysis.
CBT	Computer Based Tool.
CDN	Cost of Doing Nothing.
CIM	Computer Integrated Manufacturing.
CIM OSA	Computer Integrated Manufacturing Open Systems Architecture.
CNC	Computer Numerical Control.
Contrib.	Contribution.
COQS	Cost of Quality Schedule.
CW	Company Wide.
CW/M	Where Company Wide Management can change.
CW/S	Where Company Wide Support Design can change.
DCF	Discounted Cash Flow.
DEM	Design for Economic Assembly.
DFA	Design For Assembly.
DFM	Design For Manufacture.
DFT	Design For Test.
Dn	Deliverable where n is the number, eg. D1 = Deliverable One.
DNC	Distributed Numerical Control.
DTI	Department of Trade and Industry.
DTP	Desk Top Publishing.
EAV	Equivalent Annual Value.
EDI	Electronic Data Interchange.
eg.	For example.
EMIP	Equivalent Maximum Investment Period.
EYT	Extended Yield Technique.
FAAS	Flexible Automated Assembly System.
FAS	Flexible Assembly System..
Fc	Fixed Costs.
FMS	Flexible Manufacturing System.
Fn	Annual Cash Flow for Year n.

IC	Increase Capacity.
ICS	Improve Customer Service.
IDP	Improve Delivery Performance.
IFF	Improve Functions and Features.
Inc.	Income.
Infl.	Inflation.
Int.	Bank Base Rate.
IPQ	Improve Product Quality.
IRR	Internal Rate of Return.
IVAN	Investment Analysis Software.
JIT	Just In Time.
L	Life of Investment or Project.
LCC	Life Cycle Costing.
Mat.	Materials.
MCS	Monte Carlo Simulation.
MRP	Materials Requirements Planning.
MRPII	Manufacturing Resource Planning.
MSh	Market Share.
n	Number of Years.
No.	Number.
OPT	Optimised Production Technology.
OSA	Open Systems Architecture.
P	Unit Price.
P&L	Profit and Loss Account.
pa	Per Annum.
PB	Payback Period.
PFn	Pro-Forma, where n is the number, eg. PF1 = Pro-Forma One.
Prc	Price.
PROFIT	Program for Financing Investments in Technology.
QC	Quality Circles.
QTR	Quarter.
r	Rate of Interest.
RC	Reduce Costs.
RLT	Reduce Lead Time.
RM	Raw Materials.
ROI	Return On Investment.
ROS	Return On Sales.
ROT	Return On Turnover.
SA	Sensitivity Analysis.
SP's	Sales Products.
SPC	Statistical Process Control.
SPn	Sales Product where n = number, SP5 = Sales Product No. Five.
TCA	Total Costs Absorbed.
Tot.	Total.
TQM	Total Quality Management.
TSR	Total Sales Revenue.
TTT	Tools, Techniques and Technologies.
TVC	Total Variable Costs.
V	Variable Costs.
Var	Variance.
Vol	Volume.
WIP	Work In Progress.

## **Chapter 1.0 Introduction**

### **1.1 Background**

Traditional cost justification techniques in manufacturing industry have their origins in the era of mass production of standardised products. In a time when direct labour often accounted for more than 50% of products costs [1], high inventory levels were encouraged to safeguard against unforeseen problems and quality was inspected in on the shop floor. At this time, new machines replaced old machines one for one and productivity was improved by increasing output from operator and machine. For most companies such days are gone [2]. The environment for many manufacturing businesses has changed dramatically and new cost justification techniques are needed to meet the changed circumstances [3].

Now, many companies are involved in an international race for improved product quality, lower manufacturing costs, shorter lead times and increased responsiveness to changes in market and customer demands [4], [5], [6]. This situation has led to the deployment of a new generation of manufacturing solutions. These solutions, frequently comprising of complex combinations of manufacturing technologies, tools and techniques, are needed to achieve breakthroughs in competitiveness [7], [8], [9], [10], [11]. A number of authors [12], [13], [14], [15] have recognised that a new approach to cost justification is required if the full consequences of such investments are to be understood.

In addition where companies continue to follow traditional cost justification approaches the analysis tends to be biased towards short term criteria and may



encourage managers to seek short term solutions achieved through reductions in areas [4], such as research and development, training and new technology. Areas which are, arguably, vital to the long term competitive and strategic advantage of the company [3]. Such dysfunctional strategies are frequently adopted because the full implications and consequences of the reductions are not fully understood [10].

Even when new cost justification approaches, for example, IVAN [16 ], are used which quantify the so-called intangible or in-direct benefits of investment, each investment is evaluated discretely and consequently fails to show the full company wide impact of a coherent programme of investment. The highly integrated nature of current manufacturing operations - research and development, engineering, production, sales and marketing, administration and finance, sub-contractors and suppliers, further compounds this problem. Consequently, it is essential that the full impact of a programme of investments, each of which may be capable of generating both tangible and intangible benefits and which impact on many areas of a company's operations are fully understood so that their overall impact on the business can be determined.

The following list illustrates some, but by no means all, of investments which might be considered to have a company wide impact and which could be implemented together as part of a coherent improvement programme:

- Total Quality Management
- Just In Time
- Cellular Manufacturing
- Business Process Simplification
- Automatic Guided Vehicles
- Vendor Rating Management
- Training

In addition existing cost justification techniques have not been designed to provide assistance in identifying business needs nor linking business needs to manufacturing technologies, tools and techniques. Whilst this requirement may be considered to fall outside the remit of traditional cost justification, business needs must be considered if appropriate investments are to be selected.

By accepting that it would be useful to provide a mechanism for identifying business needs, a means of matching business needs to manufacturing tools, techniques and technologies would provide considerable additional advantage.

### **1.2 The Finjust Project**

In order to address the deficiencies outlined above, the failure to consider investments on a 'Company Wide basis' and the bias towards short term profitability at the expense of long term strategic priorities, the Finjust project was launched in 1991 with support of the UK's Department of Trade and Industry and lasted 15 months.

The principal objectives of the Finjust project [17] were as follows:

- To research the need and feasibility of an improved method of justifying the investments of small and medium manufacturing enterprises (SME's) in Advanced Manufacturing Technologies (AMT's) and techniques of Computer Integrated Manufacturing (CIM).
- To develop a formal methodology which fulfils the requirements identified.
- To develop a prototype computer based tool (CBT) which implements the methodology as an easy to use and inexpensive software package.

The project involved the collaboration of three companies, Quintec Applied Systems, Mundy Johnson Consultants and Entrepreneurial Technologies, with a further six companies involved in the testing of the methodology and tool.

The work involved the further development of an approach originally developed by Mundy Johnson, into a new cost justification methodology and supporting it with a computer based tool. Quintec Systems, the Project Leader were responsible for the development of the software, Mundy Johnson and Entrepreneurial Technologies for the methodology development and testing.

As part of his research, the author worked with Entrepreneurial Technologies and was solely responsible for the strategy which identified the links between business needs and technologies. The author's involvement in the project allowed the strategy to be tested in the collaborating companies.

### **1.3 Research Programme**

The aim of the author's research is, in addition to identifying and structuring the links between business needs and technologies and the benefits associated with specific investments, to extend the scope, functionally and ease of use of the Finjust methodology and tool and correct certain errors and inconsistencies.

To do this, the justification process will be applied to, not only, the simple discrete investments, such as machine tools, but also the more complex investments in integrated manufacturing solutions, such as, cellular manufacturing, Just In Time (JIT), Kanban, business process simplification, etc., arising from the integration of equipment, systems and people which impact on the whole business.

The results of this work will provide the data for the specification and building of an improved methodology in the form of a workbook and the specification for a

prototype computer based tool (CBT). This will necessitate a vigorous assessment of the 'company wide' benefits and cost justification criteria, including rules, data structures, decision criteria, strategic relationships and actions, and then assembling them into a coherent whole.

#### **1.4 Contribution of Research**

The major contribution of the research lies in the development of a new methodology, for use by Small and Medium Enterprises (SME's) and, therefore, is not directed at the needs of shareholders. The research, whilst based on some of the principles developed in the Finjust project, incorporates many new ideas which significantly improve its value to SME's in manufacturing. Particularly:

- Provides a process methodology that allows for analysis of both discrete investments and coherent investment programmes.
- Identifies and structures the links between business needs and investments in manufacturing tools, techniques and technologies.
- Provides detailed guidelines on how appropriate manufacturing solutions can be identified to address business needs.
- Improves ownership and commitment to the manufacturing solutions identified by fully involving relevant company personnel in the identification of business needs, the generation of solutions and the financial justification of proposed investments.
- Provide a mechanism to facilitate management development and training in financial justification by providing rationales for each activity, pro-formas for the collection of data, toolkits to help in the completion of deliverables.

## **1.5 Significance of the Work**

The new methodology will significantly extend both the functionality and ease of use of the Finjust approach and correct certain errors and inconsistencies.

Traditional cost justification techniques, developments of traditional techniques, probabilistic approaches and other 'new' approaches, will be interrogated to ensure that their advantages are incorporated into the new methodology.

As every manufacturing company at one time or another has to invest in its business in order to improve its competitive position, the full implications of any new investment must be considered. No longer is it possible to consider the effect investment has on specific sections of a business, new investment can effect many diverse areas of a business, from research and development to design, manufacturing, assembly, administration, management, suppliers, customers, etc. Subsequently, the new approach must consider the 'company wide' impact of new investment on a business.

## **1.6 Structure of this Thesis**

Chapter 1 has established the need for a new approach to the cost justification of investments for manufacturing enterprises. The new approach must be structured to guide businesses through the complexities of cost justification, so that they can realise the full company wide effect of new investments.

Chapter 2 identifies the research methodology adopted by the author to investigate the current approaches and to develop an improved approach.

Chapter 3 researches traditional cost justification techniques, identifying the advantages and disadvantages of these methods. Techniques developed to redress some of the disadvantages associated with the traditional techniques are also considered.

Chapter 4 investigates processes in cost justification. The advantages and disadvantages of probabilistic techniques are discussed in relation to cost justification and in the quantification of intangible benefits. The suitability of adapting the processes common to Japan are considered, as are the alternative methods for assisting in identifying intangible benefits and the investment analysis tool IVAN.

Chapter 5 explains the Finjust project and analyses the advantages and disadvantages inherent in the methodology and computer based tool (CBT).

Chapter 6 examines the financial and costing methods used in manufacturing businesses. The main finance accounting systems of the Manufacturing, Trading, Profit and Loss, Appropriation accounts and the Balance Sheet are described. The importance of accurate product costing and the anomalies of overhead allocation are discussed.

Chapter 7 compares the deficiencies of all the current techniques, approaches and processes identified and discussed in earlier chapters. By assessing the deficiencies suitable improvements are identified to form the basis of a radically new approach.

Chapter 8 stipulates the specification for a new approach, entitled PROFIT. By adopting the advantages of other approaches and processes to cost justification and through the creation of new concepts, the PROFIT methodology addresses many of the errors and inconsistencies of the Finjust project. Through the

identification of additional specifications the new approach extends the functionality and scope of the Finjust project considerably.

In Chapter 9 the requirements and relevance of possible business needs are discussed. The relationship between the sales and cost factors of the profit and loss account and the business needs are then identified, enabling the automation of this process in the computer based tool. The criteria for checking the capability of a company to change its business processes is then considered, allowing recommendations to be made regarding potential investments. To ascertain the company wide benefits of particular investments a Business Needs and the Potential for Change questionnaire is used .

Chapter 10 describes, through the use of flow diagrams, the main structure of the PROFIT Methodology and evaluates , through two test cases the PROFIT Methodology. This chapter also explains the procedures used to encourage ownership and commitment to the methodology, the methods employed to collect the relevant data, the areas where help and assistance are provided to complete specific tasks and the process used to ensure that each specific task is completed at the appropriate time and in the required sequence.

Chapter 11 concludes the work and through recommendations suggests ways in which the work may be developed in the future.

Appendix I includes diagrams and charts relevant to specific chapters.

Appendix II details papers presented in relation to this thesis.

Appendix III reports on the testing of the PROFIT Workbook in two companies. One of the companies uses the PROFIT Methodology to identify possible investments to meet its business need and then financially evaluates the

outcome. The other company seeks to identify its business needs and identify possible investments before entering into the financial evaluation stage of the methodology.

Appendix IV details the full workbook of the PROFIT Methodology, as it is intended to be used by companies in the identification of business need(s), identification of possible investments and their financial evaluation and for the financial evaluation of known investments.

### **1.7 Summary**

The cost justification of new investments in manufacturing businesses currently relies on the use of traditional cost justification techniques which concentrate on the area of implementation, consider only the tangible benefits and support the application of 'hurdle' rates that must be exceeded. New approaches to cost justification, such as, IVAN, have redressed some of the deficiencies by quantifying the intangible benefits. New approaches that rely on subjectivity are unacceptable by the very fact that they are open to personal bias. Other approaches are not accepted by accountants as 'sound accounting practices'. The Finjust methodology and tool incorporates a number of errors and inconsistencies.

This research is targeted at SME's and, therefore, is not directed at the needs of shareholders and/or large manufacturing companies.

This work provides an original approach to the problems by:

- Providing detailed guidance on the tasks involved in the cost justification of new investments.



- Identifying and structuring the links between business needs and technologies.
- Identifying the benefits for specific investments.
- Improving the ownership and commitment of a company to the new approach.
- Improving management development and training in financial justification.

## **Chapter 2.0 Research Methodology**

### **2.1 Introduction**

In order to achieve the research objectives, a combination of data collection, analysis and synthesis techniques, need to be employed. The rationale for the use of each technique is outlined below.

### **2.2 Data Collection Method**

In identifying sources for data collection on current cost justification issues it was quickly recognised that manufacturing companies themselves would provide a valuable source of information. Additional information could be obtained from the extensive literature on financial justification expressing the experiences and views of academics and management consultants.

#### **2.2.1 Literature Search**

Before consulting manufacturing companies directly a comprehensive literature survey was undertaken to identify current approaches and recent developments.

The literature survey provided details of cost justification approaches, processes and techniques. Extensive use was made of the on-line databases of abstracts through the University's library service encompassing UK, continental Europe, US and Japanese work.

Initial searches were conducted in the areas of:

Investment Analysis.

Cost justification of:

Computer Integrated Manufacturing (CIM), Advanced Manufacturing Technologies (AMT), Engineering Investment.

Accounting:

Management, Manufacturing, Business.

Implementation of:

Computer Integrated Manufacturing (CIM), Materials Requirement Planning (MRP), Manufacturing Resource Planning (MRPII), Just In Time (JIT), Kanban, Total Quality Management, Design For assembly (DFA), Design for Manufacture (DFM), Computer Aided Design (CAD), Computer Aided Design and manufacture (CAD/CAM).

Corporate Strategy.

Structured Analysis Systems, Methodologies.

From the literature surveys it became apparent that companies who relied on purely strategic considerations, necessary to achieve the business goals and objectives of a company, although successful in some cases have proved to be expensive mistakes for others [8].

The cost justification of new manufacturing investment requires detailed cost and benefit analysis on a company wide basis. New manufacturing investments involve all areas of a company, therefore, costs should be analysed on a 'company wide' basis. This necessitates the inclusion of the hitherto unidentified factors in cost justification. According to Gold (18) "In most firms, proposals for technological innovations are expected to emerge from, or at least to be

approved by, the operating sectors most likely to be affected by them". Senker [19], "firms normally justify the costs associated with CAD by relying on labour savings from employees, such as draughtsmen and estimators". Primrose, Creamer and Leonard [10], in respect to the design function, point out that this function often only represents less than one percent of the total cost of sales and therefore, concentrating the appraisal of CAD in this one area (by the reduction of draughtsmen) is likely to fail to recognise the potential of CAD in non-drawing office areas. It is only by correctly identifying the 'company wide' benefits of CAD that a rigorous investment appraisal can be carried out, enabling the company to concentrate its resources on the areas that will maximise the advantage.

Also, traditional approaches to the cost justification of new manufacturing investments rely solely on tangible benefits. However, Noble [8] wrote, "benefits that are difficult to quantify, such as improved quality and increased flexibility, are generally not included in traditional cost analysis. This in effect assigns intangible benefits a value of zero". Bonsack [9], "CIM equipment and related systems provide significant benefits which traditional accounting and budgeting methods do not recognise". Hunt [22] wrote, "that non-economic benefits, such as improved quality, were usually presented for management as of sub-ordinate consideration".

### **2.2.2 Data from Companies**

The data collected from companies related to past investment decisions and, therefore, provided not only, data on the cost justification processes used, but also data on the particular new investments under analysis. However, due to the sensitivity of much of the financial cost data, actual figures were not available.

The companies collaborating in the research represented a broad spectrum of sizes, industrial sectors, profitability and included one vendor of manufacturing automation equipment and one consultancy company specialising in financial justification.

The industrial sectors included PCB fabrication (large multi-national), scientific instrumentation (small company, 27 employees), fluid dispensing (small company 65 employee's), automotive presswork (large company, 279 employees). Each of these companies were, or had recently been involved in the financial justification of either a programme of investments or a discrete investment.

Data was obtained using a combination of structured interviews, examination of cost justification documentation and discussion and review of actual case examples.

The data obtained included:

- Methods adopted for cost justification.
- Attitudes of management to cost justification techniques.
- Awareness of technologies and their benefits
- Examples of the types of analysis carried out.

### **2.3 Development Potential**

The aim of the research phase was to determine the current status amongst manufacturing companies towards cost justification of new investments. Also to identify as many as possible of current approaches, their advantages and disadvantages and the potential for improvement.

The result, which would be developed from the findings, would produce a structured methodological approach to the cost justification of new manufacturing investment. The methodology would guide companies through a framework of tasks supported by techniques of proven capability.

As ideas developed they were presented to management consultants, companies involved in cost justifying new investments and academics who could add their experience to testing the validity of the methodology and stimulate further contributions. Through such activities the methodology was assured of being practical, valid and based on accepted accounting practices.

#### **2.4 Testing the Methodology and Tool**

The methodology was first tested against case histories of companies who had implemented investments, allowing comparisons to be made with the predicted outcome from the methodology and the actual outcome chosen by the companies.

The logic and structure of the approach was tested via presentations to SME's and consultants. The methodology was also discussed with academics and businessmen during presentations at conferences in Miami, Sweden and Paris.

The ultimate test of the methodology is to apply the methodology and tool in a company considering making an investment to improve its business. Two such companies were identified and testing was undertaken successfully. Whilst this enabled the functionality of the methodology and its ease of application to be tested it could not assess its full potential in identifying appropriate and resilient investments. This assessment can only be determined over time. The reports on the testing are detailed in Appendix III.

## **2.5 Summary**

The research methodology has been described specifying the major areas of literature to be reviewed in order to provide a sound theoretical basis for the research. The role of the collaborating companies has been described and their contribution in testing the methodology outlined. The testing of the ongoing and completed methodology, manually on Company A and Company B, is discussed in Appendix III.

## Chapter 3.0 Traditional Cost Justification Techniques

### 3.1 Traditional Cost Justification Techniques

This Chapter identifies and discusses the advantages and disadvantages of traditional cost justification techniques used in evaluating investment decisions. The most frequently encountered techniques are discussed first, followed by less well known approaches that have been developed to redress some of the disadvantages of the traditional techniques.

#### **3.1.1 Payback Period**

Payback Period, this method calculates the time required to recover the investment [23]. It is easy to compute and understand. Payback Period can be calculated as shown in figure 1, using:

$$\text{Payback Period (years)} = \text{Net Investment} / \text{Average Annual Cash Flows}$$

Year	Net Cash Flow	years	months
0	-1420		0
1	750	1	0
2	400	1	0
3	200	1	0
4	100		8
5	50		
Payback Period (Years+Months) =		3	8

Figure 1 Example of Payback Period.

By setting a target Payback Period for all investment decisions, a company can easily decide if a proposal is acceptable [8].



The advantages of the Payback Period are most appreciated where future sales volumes are unreliable and where equipment and/or products are likely to have a short cycle life [25]. Also, Payback Period provides consideration of the risk of the investment because it reflects the liquidity of the project [26] and, according to Pike and Ooi [20a], Payback Period is relied upon more heavily when economic uncertainty is greater.

Although the main disadvantage of Payback Period is that it does not incorporate the time value of money, this can be overcome by the use of the Discounted Payback [21], [27]. However, there still exists other disadvantages, such as, it does not identify how much profit, if any, the project will make nor how much income might be received after payback. Also, it is inadequate for rigorous analysis of all the variables [28], takes no account of the product's life, such as, a bridge lasting 100 years or a ferry lasting 25 years [29], and because it ignores the timing of the cash flows, it is unsuitable for the systematic comparison of alternatives [29]. For example, in figure 2, while Product A has a shorter Payback Period, it has recovered only 55% after three years, while Product B has recovered 80%.

Time Years>>	Cost	1	2	3	4	5	6	7	8
Product A	10000	2000	2000	1500	3500	1000			
Accumulated % Recovered		20%	40%	55%	90%	100%			
Product B	10000	4500	3000	500	500	500	500	200	300
Accumulated % Recovered		45%	75%	80%	85%	90%	95%	97%	100%

Figure 2 Payback Period - Comparison of Products with Different Cash Flows.

### 3.1.2 Break Even Analysis

Break Even Analysis, as the name suggests, is the point at which the company will have covered its costs - neither making a profit or a loss - for a particular investment or product development programme. Whereas Payback Period

provides a time value in which to recover investment costs, Break Even Analysis provides a company with a figure for either the volume or the value of sales required to recover the investment [24].

The formula for calculating the Break Even point in unit volume is:

$$BE(\text{Units}) = F/(P-V)$$

The formula for calculating the Break Even point in monetary terms is:

$$BE(\pounds) = F/(1-(V/P))$$

Where: F = Fixed costs, P = Unit price, V = Variable cost per unit

Like Payback Period, Break Even Analysis when based only on a simple equation, does not provide a company with any information on future profits or losses after the Break Even point has been calculated. However, the Break Even point calculation can also be represented in the form of a Break Even chart, which will show the level of profit or loss at any given level of output, thereby, addressing this disadvantage. For example if a company had Fixed Costs of £1200, Total Production Capacity of 5000 Units, Sales of 5000 Units at £1 each and Variable Costs of 60p per Unit then the following chart would show:

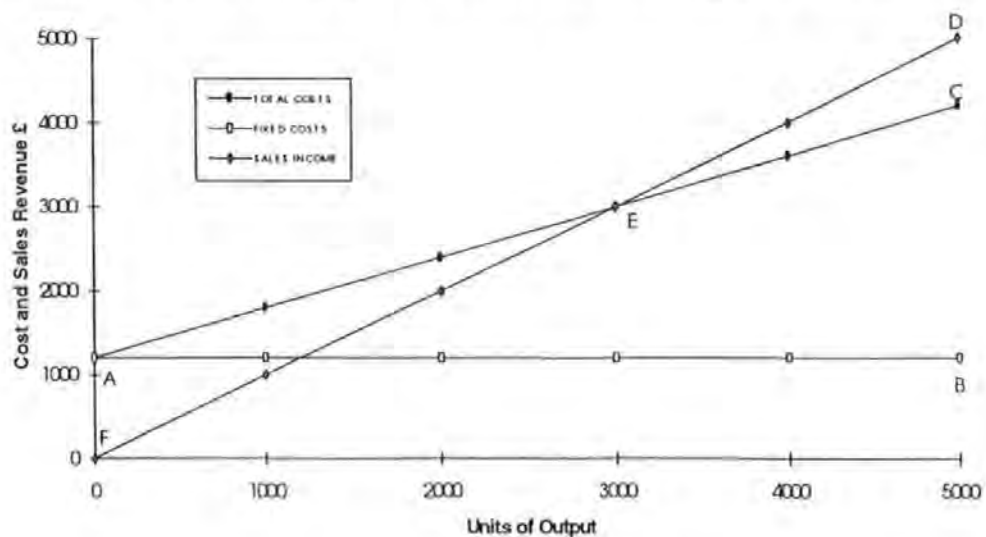


Figure 3 Break Even Analysis Chart.

In the chart the variable costs are shown in the area ABC and increase directly in proportion to increases in the level of output. Fixed costs are represented by the straight line AB and therefore, the line AC represents the total costs at any given point of production. Where the line FD, which represents sales income, crosses line AC at the point E is the Break Even point. The area AEF represents the operating loss at given levels of output and the area ECD the operating profit.

Where changes in fixed costs occur, multiple Break Even point Charts can be employed to present a more realistic picture.

The main advantages of Break Even Analysis is its suitability for problems where a heavy initial investment is repayable in proportion to the volume of production [30].

A major disadvantage of both single and multiple Break Even charts is that once the Break Even point has been passed it would appear that the gap between total cost and total income continues to increase at a constant rate. This is seldom likely to occur because, even with products that are 'household' names, sales will reach a plateau at which sales income will tend to decrease due to the costs of maintaining sales and production activities [8].

Other disadvantages include, identifying and apportioning the fixed and variable costs to specific products, assuming that all products are sold and that there is no significant change in the inventory [29].

### **3.1.3 Net Present Value**

Net Present Value (NPV) is the investment cost minus the discounted cash flows. The NPV provides a value for a future investment, in terms of its current value to the business. If the NPV is negative then the investment cannot be justified, if it is

near zero, then at least the investment has earned interest for the business at a pre-determined rate. However, if the NPV is positive, then this is the present day equivalent of the money earned by the investment, after it has paid interest at the pre-determined rate [31]. The NPV can be calculated by the equation [32]:

$$NPV = \sum_{n=0}^L F_n / (1+r)^n$$

Where; n = Years,  $F_n$  = Annual cash flows for year n, r = the rate of interest, L = the life of the Investment (Project).

The advantage of NPV, is that it can show the equivalent value at present of a complicated future investment.

The main disadvantage of NPV is that the profitability is not referred to the capital required to produce it and even where the NPV is high, projects could be refused because of the large amounts of capital outlay involved.

### 3.1.4 Internal Rate of Return

Internal Rate of Return (IRR) is the required rate of return at which the NPV is zero [33]. To calculate the IRR adjust r until  $NPV = 0$  in the equation [32]:

$$NPV = 0 = \sum_{n=0}^L F_n / (1+r)^n$$

Where; n = Years,  $F_n$  = Annual cash flows for year n, r = the rate of interest, L = the life of the Investment (Project).

The advantages of IRR are its ease of use and understanding, and that it can be used to compare alternative investment decisions.

The main disadvantage being that the IRR gives meaningless results in situations where cash flows are initially positive, but there is a large negative flow appearing near the end of the project.

### **3.1.5 Return on Investment**

Return On Investment (ROI), is the net income divided by the capital invested and can be multiplied by 100 to determine the percentage. If the rate is lower than that set by the company - commonly known as the hurdle rate - then, according to the underlying rationale of this approach, the investment is justified.

The disadvantages are that ROI cannot be used in areas where capital investment fluctuates frequently and it can make situations unattractive where the capital investment will be large in the future.

Also, there is a tendency amongst companies to set the hurdle rate far above the actual cost of capital or the rate of return that they could expect from alternative investments. This is seldom a wise decision. By using artificially high hurdle rates some companies believe they can protect themselves from unforeseen reductions forced on them by aggressive competitors or unexpected inflationary increases in investment costs. Unfortunately, high hurdle rates encourage the attitude of 'think today far more than tomorrow' [31], encouraging short term objectives at the expense of long term strategic issues [15] and Pike [20b] suggests that in an effort to mitigate the effects of biased forecasting and non-economic investment, some firms may be guilty of killing off potentially sound projects by setting unrealistically high hurdle rates.

For example, take two companies, the first is in the process of implementing new technology. The second is faced with having to decide if it should do the same. A proposal is presented for top management to justify. But the company's high hurdle rates cannot be met, so the company does nothing. No attempt has been made to find out what the consequences of 'doing nothing' might be. Sometime later the first company, through improved performance achieved by its successful implementation of new technology, is able to reduce the retail price of its products, resulting in a gain in market share at the second company's expense. The second company puts forward another proposal, but because their profits have been squeezed by the loss in market share, the returns are far worse than before and the high hurdle rates still exist. As a result the second company still cannot justify the new investment.

This hypothetical case illustrates the risks involved of applying unnecessarily high hurdle rates, the cost of not considering the effect of 'doing nothing' [15], [34], [35], the price that could be paid for being one step behind the competition [36] and the effect of hoarding [37] in preference to investing.

The overriding disadvantage of ROI based techniques is that they can be manipulated on a period-to-period basis (by avoiding new capital outlays) which puts long term prosperity at risk [38]. Where sales are low or costs are high, making profit targets hard to achieve, managers are encouraged to increase short term earnings by cutting expenditure on Research and Development, advertising and promotions, quality improvement, new investments, human resources, customer relations, delivery, etc., - all vital to a company's long term performance. The immediate effect of such reductions is to increase reported profitability, but at the risk of sacrificing the company's competitive position [39].

### 3.1.6 Cash Budgets

Cash budgets are used to show the projected sources, uses of cash and the financial balance over a pre-determined period of time, be it daily, weekly, monthly, quarterly or yearly. Their use in financial investment appraisal [8], [40] allows a company to:-

- Ensure that there are sufficient funds available to support the working capital position required for effective trading.
- Ensure that sufficient funds will be available to meet the company's planned capital expenditure and investment programme.
- Ensure that cash funds will not be surplus to requirements resulting in under employment of resources.
- Identify potential future negative cash flows. By being forewarned of a possible negative cash flow a company will be in the position to take corrective action or arrange additional external funding, whichever is seen as the most appropriate for the circumstances.

	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter		
	Plan	Act	Var	Plan	Act	Var	Plan	Act	Var	Plan	Act	Var
<b>INCOME:</b>												
Sales	250	220	-30	345	500	155	400			200		
Services	25	12	-13	55	30	-25	45			15		
<b>TOTAL INCOME</b>	<b>275</b>	<b>232</b>	<b>-43</b>	<b>400</b>	<b>530</b>	<b>130</b>	<b>445</b>			<b>215</b>		
<b>EXPENDITURE:</b>												
Materials	125	130	5	200	275	75	225			120		
Labour	50	70	20	70	90	20	80			40		
Inventory	23	10	-13	25	35	10	45			20		
Finance	7	7	0	107	120	13	7			7		
Overheads	40	50	10	45	60	15	50			16		
<b>TOTAL EXPENDITURE</b>	<b>245</b>	<b>267</b>	<b>22</b>	<b>447</b>	<b>580</b>	<b>133</b>	<b>407</b>			<b>203</b>		
Previous Qtr + Tot. Inc.	275	232	-43	430	495	65	428			236		
Total Expenditure	245	267	22	447	580	133	407			203		
Closing Balance	30	-35	-65	-17	-85	-68	21			33		

Figure 4 Example of a Cash Budget.

The main disadvantage of cash flow forecasts is their reliance on projected sales forecasts. However, by improving the standard cash flow forecast to include planned, actual and variance columns for each time period, a company can easily ascertain the accuracy of its sales forecasts and provide managers with the opportunity to identify and correct problem areas [8], as shown in figure 4. However, as this knowledge only becomes apparent in real time, any assistance to the original investment decision will be too late to be of any use, as the decision as to whether or not to implement a new technology would already have been made. If a company opts to wait and see how accurate its present sales forecasts are prior to reaching a decision on new technology valuable time is consumed and is unlikely to achieve many of the benefits that might arise from the new technology.

Where negative cash flows occur, companies requiring external financial assistance are likely to find difficulty in convincing banks and other financial institutions to provide extra borrowing facilities on the basis of projected sales forecasts, unless accompanied by confirmed sales orders.

### **3.2 Developments of Traditional Cost Justification Techniques**

Other techniques which could be potentially viable, in the cost justification of new investments, although less well known, are those developed from some of the traditional techniques previously discussed. These techniques are explored next, under separate headings.

#### **3.2.1 Benefit Cost Ratio**

Benefit Cost Ratio (BCR) [31] is the ratio of the NPV of the benefits to the discounted cost. The discount factor used is the estimated cost of capital. If this



ratio is greater than one then the project will recover more than the cost of the capital invested. This technique was developed to overcome NPV's disadvantage of not relating the investment to the capital employed. However, BCR gains another disadvantage through its use of the estimated cost of capital.

### **3.2.2 Equivalent Annual Value**

Equivalent Annual Value (EAV) [31] is the equivalent constant annual sum that a project will contribute to a company's finances, after the capital has been paid for. This enables management to quickly establish the importance of the profits involved in relation to the company's annual balance sheet. EAV is calculated using the equation [31]:

$$EAV = (NPV * r) / (1 - 1 / (1 + r)^L)$$

Where: NPV = Net Present Worth, n = Years, r = the rate of interest, L = the life of the Investment (Project).

### **3.2.3 Extended Yield Technique**

In the Extended Yield Technique (EYT) [31], if the Discounted Cash Flow (DCF) calculation provides a positive net cash flow, then the positive amount is transferred to a sinking fund, which appreciates at the company's cost of capital rate, and is used to pay off any future negative cash flows. By this action the project never has a positive net cash flow situation before a capital outlay, thus overcoming the problems that faces IRR techniques, such as;

- Meaningless results when cash flows are initially positive with large negative flows appearing near the end of the project.

- Meaningless results in investments where the capital fluctuates frequently.
- Confusing results when there is more than one capital flow in the life of a project, because this can result in more than one discount rate which can give an NPV value of zero.

### **3.2.4 Equivalent Maximum Investment Period.**

Equivalent Maximum Investment Period (EMIP) [31] determines a single figure that can be considered to be the number of years required to pay back the maximum negative cash flow balance given the same performance. This figure is calculated by dividing the total negative cash flows by the maximum negative cash flow.

EMIP is a development of the Payback Period and extends the Payback Period to projects with fluctuating cash flows and multiple capital outlays.

### **3.3 Summary**

This Chapter has examined the advantages and disadvantages associated with traditional, non probabilistic, cost justification techniques and the more recent developments of traditional techniques.

With regard to the traditional techniques, the use of Payback Period and Break Even Analysis has been shown to be valuable in identifying the time period, value and volume of sales required to recover the investment. However, the above approaches are limited, for example, Payback Period fails to provide any indication of the cash flows after the payback point has been reached and Break

Even Analysis requires the identification of fixed and variable costs - which can change, not only from business to business, but also, within a business.

Many of the traditional cost justification techniques, such as, Payback Period, Break Even Analysis, NPV, IRR, and ROI, allow for easy analysis of comparative investments, through the use of financial ratios. However, not all the techniques provide useful results. The value of the indices has also diminished, through their adaptation into hurdle rates to be exceeded before an investment is acceptable. Management that are encouraged to meet hurdle rates, as a measure of performance, can simply reduce long term investment in Research and Development, new plant, new processes, skilled workers, etc.

The traditional techniques that have been developed, although addressing some of the deficiencies, have not overcome them all. Discounted Payback Period redresses the problem of the time value of money associated with Payback Period and Equivalent Maximum Investment Period attempts to extend the Payback Period to cover projects with unsteady, multiple cash flows. But, neither method redresses the disadvantage of identifying the amount of cash flows that occur after the payback point has been reached.

Benefit Cost Ratio addresses some of the disadvantages of NPV, such as not referring profits to capital, however, through its use of the estimated cost of capital, it limits the value of the results provided. Extended Yield was developed to redress some of IRR's meaningless results when cash flows were initially positive and then negative and the disadvantage of more than one discount rate giving an NPV of zero.

Cash Budgets provide useful information regarding the capital investment status of a company, however, their disadvantages include the reliance on estimated data and the lack of inclusion of the time value of money.

None of the traditional techniques to cost justification suggest methods to quantify the intangible benefits, such as, improved quality, reduced lead times and improved flexibility. But improved quality could command a premium price, providing increased profits. Reduced lead times could provide a company with the edge over other companies in winning a new contract. Improved flexibility could provide the opportunity to make to order, resulting in savings in capital tied up in inventory.

Even when a combination of the most frequently adopted and the less well known traditional cost justification techniques are used, a major disadvantage remains - they fail to show the Company Wide effect that these types of investment can generate.

The integration of the whole business - research and development, engineering, production and business planning, sales and marketing, administration and finance, sub-contractors and suppliers, senior management - demands an understanding of the 'company wide' effect investments have on a business.

## Chapter 4.0 Alternative Cost Justification Techniques and Processes

### 4.1 Probabilistic Techniques

When forecasting future events inaccuracies are likely to occur in the resulting data. However, in many instances the magnitude of the inaccuracies can be estimated for the best, worst and expected values or by using a probability distribution.

In the probability distribution shown in figure 5 the Y-axis has no units because it is plotting relative frequency. The X-axis gives the range that the data can take and the height of the curve indicates the relative probability of it occurring. The area under the curve is the probability.

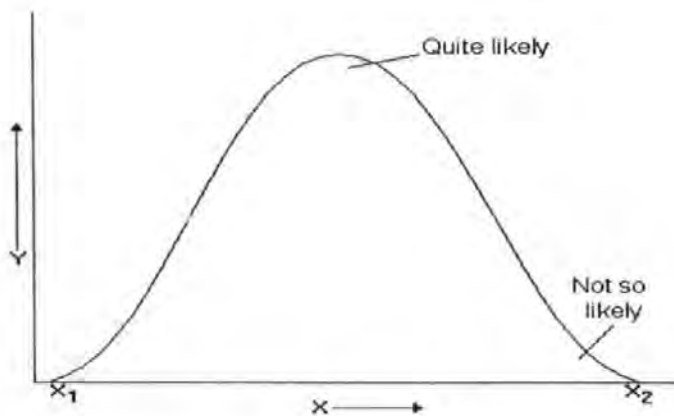


Figure 5 Probability Curve.

The decision as to whether to accept or reject an investment is likely to be influenced by the reliability of the estimated data. For example, if predicted future sales volume had a 75% chance of being achieved it would carry far greater credence than if the chances were only one in ten. Also, the risks associated with an investment could effect the rate of interest that would be

charged, as stated by Pike [20c], "in efficient capital markets the market rate of interest will be commensurate with the risks associated with the funds raised ".

Techniques that fall into the probabilistic category include:

1. Cost/Benefit Analysis
2. Risk Analysis:
  - Sensitivity Analysis
  - Monte Carlo Simulation
  - Alternative risk evaluation techniques.

#### **4.1.1 Cost/Benefit Analysis**

The basic technique used in Cost/Benefit Analysis is shown in figures 6 and 7 and for each proposal requires [8]:

1. Assigning a value to each risk factor that represents its ability to meet the strategic objective.
2. Assigning a weight to each risk factor that represents its importance in meeting the strategic objective.
3. For each risk factor multiply the value by the weight to find the score.
4. Total the scores for all the risk factors.

The project that provides the highest score, is the one most likely to meet the strategic objectives. Therefore, because the score in figure 6 is only 228 as opposed to 284 in figure 7, the most likely investment would be Continuous Improvement Monitoring.

The advantages of Cost/Benefit Analysis include its ability to provide a value of importance to intangible benefits, such as, improved quality, reduced lead time, etc. and its ease of use.

Objective: Reduce Lead Time			
Operator Inspection Scheme			
	Risk Factor	Weight	Score
Benefits:	(1 to 10)	(1 to 5)	
Reduce Scrap & Rework	5	3	15
Reduced Absenteeism	10	5	50
Operator 'Ownership'	10	5	50
Retention of Skilled Workers	10	5	50
Reduced overtime	9	5	45
Increased Flexibility	6	3	18
Total Score			228

Figure 6 Example of Cost/Benefit Analysis

Objective: Reduce lead Time			
Continuous Improvement Monitoring			
	Risk Factor	Weight	Score
Benefits:	(1 to 10)	(1 to 5)	
Reduced Scrap & Rework	5	3	15
Reduced Absenteeism	9	5	45
Fewer 'Fire Fighting Teams'	9	5	45
Reduced WIP	4	2	8
Improved Throughput	8	4	32
Increased Flexibility	6	3	18
Reduced Errors in:			0
Production	8	5	40
Sales Orders	9	4	36
Invoices	6	5	30
Sales Literature	3	5	15
Total Score			284

Figure 7 Example of Cost/Benefit Analysis.

Its disadvantages according to Reeve, [41] include:

- The use of subjective reasoning.
- The outputs are not subject to rigorous defence.
- Assumes independence of the operational factors.

### **4.1.2 Risk Analysis**

The three commonly used methods in Risk Analysis are described below.

#### **Sensitivity Analysis.**

The rationale for using Sensitivity Analysis to identify the specific risk factors that contribute to the overall risk of a proposed project is well expressed by Rose [31].

By listing the factors for the proposed project, those that are at risk are subjected to a sensitivity calculation. This calculation involves changing one risk factor at a time by a pre-determined amount (for example 10%). When all the factors at risk have been analysed, the importance of the change, for each risk factor on the overall proposed project, can be evaluated.

Sensitivity analysis does not directly lead to a definite decision regarding an investment proposal, but it does pin-point areas where future work should concentrate in order to highlight the most significant risks, enabling the project to be re-designed to avoid or at least minimise these risks.

#### **Monte Carlo Simulation.**

Monte Carlo Simulation consists of expressing all the probabilistic data in terms of cumulative probabilities, and then by using a random number generator obtain a number that is taken as the probability on a cumulative probability graph. The corresponding value of the variable can then be read from the graph and used in the calculation. The process is repeated for each probabilistic



variable using a new random number each time. When all the probabilistic data has been generated the evaluation can be made [31].

The whole procedure is then repeated until sufficient accuracy has been achieved. The more times it is repeated the greater the accuracy. The results can then be expressed as a frequency distribution, from which the expected value can be calculated.

The main reasons for carrying out a Monte Carlo simulation are that it shows the combined effect of the uncertainties and acts as an aid to the decision maker as to whether to accept or reject an investment proposal [27].

The advantages of Monte Carlo Simulation as identified by Reeve [41] include:

- The simulation can be built from known data without understanding all aspects of the problem.
- The output is easily interpreted.
- Sensitivity analysis can be used to explore changes on variables
- Provides expected value and variance of returns.
- Can be designed to evaluate time phased investments.

The main disadvantage of Monte Carlo Simulation is the large number of repeats required to improve the accuracy of the results, although reducing the variance of the data can improve the results, this is not always feasible. Dixon [42] says of Monte Carlo Simulation "its disadvantage is that it is only as good as the individual who operates it". Reeve [41] also identified the following disadvantages:

- Values estimated subjectively.

- Requires specialist skill to formulate investment problem in a form that can be computed.
- As it is customised, rather than generalised, it could prove expensive.

### **Alternative Risk Evaluation Techniques**

Sub-optimal investment decisions could result, for example, in the sale of successful investments at bargain prices, abandonment of promising new projects, emphasis on short term projects to generate cash, avoidance of highly profitable long term projects with poor short term returns, reduced investment in training, research and development and reduction in credit terms with suppliers.

Option Pricing Theory enables the calculation of the optimal debt-equity ratio, this is very useful, because, increasing the amount of debt could increase the financial risk of new investment. The Black-Scholes model demonstrates that the existence of repayable debt in a company's investment schedule can result in a transfer of wealth from the holders of debt to the owners of equity [20d].

Capital Asset Pricing as suggested by Sharpe [21] includes generating a market sensitivity for each security as the appropriate measure of portfolio risk, rather than total risk as measured by standard deviation. This enables returns to be related directly to unavoidable risk .

### **4.2 The Japanese Approach**

Fifty years ago the reputation of the Japanese was based on cheap, low quality products [43]. Since then they have developed into one of the World's leading industrial nations producing high quality goods, capable of competing with the rest of the world and winning. How was this metamorphosis achieved?

They are amongst the first to admit that they listened to the innovators of Western Business Management in the early Fifties, such as Demming's Total Quality Philosophy, but this is where the similarity ends. For unlike the West they whole heartedly embraced such methodologies. They set a long term strategic goal and strived to achieve it.

Over the intervening years they modified and adapted these methods to meet their own requirements. They are continuing to modify and adapt to stay competitive [44]. They are still being creative. Therefore, an analysis of Japanese cost justification techniques could provide a valuable insight into the cost justification of new manufacturing investment.

In Sakurai's and Huang's January 1988 survey [45] in Japan of appraisal methods used for investment justification, 65% of companies used the Payback Period, 6% IRR, just over 10% NPV and nearly 16% a combination of methods. In the implementation of Factory Automation Systems the use of Payback Period method rose to 75%.

The reasons claimed [45] for using the Payback Period include:

- In a time of technological innovation, it is too risky to invest capital for an extended period. The new technology may become obsolete before the company can recover its costs.
- Life cycle times are continually reducing, increasing the risk of products becoming obsolete, thereby jeopardising long term investment. Machine and equipment life cycles are also reducing.
- Japanese managers find it difficult to predict sales volumes accurately for highly advanced products. If sales forecasts are unreliable it is pointless computing future profitability in detail.

It would appear that the Japanese consider the time factor to outweigh any of the disadvantages associated with the Payback Period. This conflicts with the long term strategic approach which many respected authors consider to be the underlying reason for the success of Japanese companies.

However, when measuring divisional and product performance, the Japanese do use a rate of return. In a survey in 1986 [45] Return On Sales (ROS) was found to be used by 46% of Japanese public companies, while ROI was used by 4%.

The main reason for not using ROS, is its failure to recognise the effective use of capital and the effect of changes in increased sales and cost reduction. However, the Japanese have addressed these deficiencies by using Asset Turnover.

Benefits associated with ROS include [46]:

- It can clearly reveal the profitability of each product in a high variety environment.
- It is useful for making make or buy decisions.
- It can be used where capital investments fluctuate frequently.
- It can be used where future capital investments will be large.
- Its use has a positive effect on workers and management.
- It is easy to understand.

Also, because cost reduction has little effect once production starts [47], the Japanese have changed their attitude from cost control in the manufacturing process to cost reduction at the design stage. This has necessitated the development of Target Costing [45], which aims to reduce the costs associated with a product over its entire life cycle. This technique requires intensive communication between production, engineering, R&D, marketing and

accounting to be successful. Using this system, Japanese management believes that costs can be reduced without compromising quality.

The Target Cost is arrived at by deducting the Target Profit from the Selling Price. Target Profit is calculated by multiplying Sales Revenue by ROS. ROS plays a critical role by setting a minimum rate of return beforehand, so that management can project both the target selling price and the cost level.

The Payback Period, ROS and Asset Turnover, as used by the Japanese may work for them, but will it work in the West? Before addressing this question, a brief overview of the Japanese approach will be provided.

The Japanese accountants work with managers in Design, Engineering and Marketing departments in an attempt to improve their management accounting systems.

In addition, the Japanese believe that in order for managers to manage effectively they must fully comprehend the management and accounting tools they use. The easier to understand a system is, the greater the likelihood of its success. Payback Period, ROS and Asset Turnover are all cited as simple to understand.

A major disadvantage, in comparing Japanese companies with those in the West, is the assumption that they operate under similar business approaches.

This was not the case in the early Fifties when the Japanese implemented new management practises while the West did little, or nothing - nor is it the case with new technology, the installation of robots in the West invariably results in high unemployment, whereas in Japan, until very recently, they prided themselves on finding employment for most, if not all, of their former employees.

In addition the Japanese include intangible benefits, such as, the elimination of dirty and dangerous work, improved quality, reduced lead time and inventory, into their calculations when cost justifying new investment.

To answer the question posed above, by adapting the approach used by the Japanese a cost justification package, incorporating Payback Period, ROS and Asset Turnover, that would be applicable to Western businesses, could be developed. What works in Japan could work in the West, provided it is modified to suit the business approach of the West.

### **4.3 The Cost of Quality Schedule**

The Cost of Quality Schedule (COQS) concentrates on identifying the areas of a company that could be improved through the application of quality improvement programmes. According to Kaplan [48] the Cost of Quality, is a "financial, system wide measure of the costs associated with preventing, testing for, or correcting defective items". The COQS covers three areas, namely:

- The Cost of Conformance.
- The Cost of Non-conformance.
- The Cost of Lost Opportunities.

#### **4.3.1 The Cost of Conformance.**

This comprises of the costs associated with those activities within a business that prevent failures occurring (Prevention) and those costs necessary to ensure that the appropriate quality levels and standards are adhered to (Appraisal). For example, training, planning, quality awareness programmes, inspection, checking, testing, etc.

COST OF QUALITY SCHEDULE						
Action:	Prevention	Appraisal	Internal Failure	External Failure	Exceeding Requirements	Lost Opportunities
Design Changes			800			
Tooling Modifications			200			
Quality Planning	100					
Rework			250			
Scrap			500			
Surplus Inventory			400			
Sales Invoice Errors				120		
Retraining Staff			20			
Unused Product Features					250	
Loss of Existing Customers						900
Production Inspection		180				
Sub Totals	100	180	2170	120	250	900
TOTAL COQS	3720					
Sales Revenue	18945					
COQS/Sales Revenue %	19.6%					

Figure 8 Example of the Cost of Quality Schedule.

#### 4.3.2 The Cost of Non-conformance.

This covers the costs associated with correcting faulty products or services prior to their delivery to the customer (Internal Failure), those costs resulting from corrections necessary after delivery to the customer (External Failure) and those costs represented by designing in functions and features that are not required by the customer (Exceeding Requirements). Examples include scrap, rework, obsolete inventory, design changes prior to, during and after production, warranty costs, recalls, invoice errors, redundant documents, etc.

#### 4.3.3 The Cost of Lost Opportunities.

This area covers the cost of sales revenue lost as a result of losing existing customers, potential new customers and failure to increase business as a result of the Cost of Conformance and/or Non-conformance. Examples cover, failure to

meet customers' requirements in terms of product range, inadequate response times, cancellation of orders and re-ordering by customers from competitors, due to poor delivery, etc. If customers believe they have bought a 'quality' product, they are likely to tell other people. However, should they be dissatisfied with the 'quality' product, then they may complain to other people.

#### **4.3.4 The COQS Discussion.**

The main advantages of the COQS are its simple format for calculating the cost of quality, as shown by the figure 8, and the potential it offers for quantifying intangible benefits. Although it is feasible for a company to complete the schedule without assistance, the COQS is predominately used as an aid for consultants in convincing companies that their major business requirement should be quality improvement [49].

The main disadvantage of the COQS is that it is not considered, by many, as a precise financial document nor a technique for financial accounting. One reason for this disadvantage, is because some of the information required to complete the schedule must, of necessity, be estimated. However, it could offer an acceptable basis for identifying and quantifying the value of the benefits and costs involved in a new investment.

#### **4.4 IVAN - Investment Analysis Software**

A computer investment program entitled IVAN (InVestment ANalysis) [16] allows engineers to evaluate proposals prior to implementation, using estimated data. Through the application of a computer program, time and human errors of manual approaches are reduced.



IVAN is a financial methodology, which by utilising Discounted Cash Flow (DCF) techniques to evaluate the ROI, measured as NPV and/or IRR, is acceptable to accountants. IVAN employs a check list that requests data from the user regarding costs and benefits of a proposal.

IVAN has identified many benefits and costs, both tangible and intangible, of new technologies on a company wide basis. The approach suggests that the quantified values of the benefits will be in the region of 1% to 2% and not exact values such as 1.25% [10].

Because the data values requested are not specific, upper and lower levels are established by the user, resulting in output by IVAN of three DCF returns. It is then left to management to establish the probability of the accuracy of the results and whether or not to proceed with the proposal.

IVAN also advocates the use of post-audits. To quote Primrose [16], " While there can be an element of over optimism from engineers trying to get projects accepted, a major cause of problems is the fact that engineers are often planning the introduction of new technology which they may have little or no operating experience of ". By undertaking post-audits, engineers can improve their knowledge of how to evaluate investments that they have experience of operating.

The advantages of IVAN include:

- The use of a computer program to reduce human error and time.
- Identification and quantification of the benefits and costs of some technologies.
- The use of quantification values that are not exact.

- The use of three possible outcomes.
- Use of post-audits to improve the understanding of investments already implemented.

The main disadvantage is:

- That rate of return methods are employed by IVAN. The temptation for management to revert to the old tried and tested methods of exceeding a pre-determined rate of return still exists. IVAN merely providing new figures, faster.

Other disadvantages include:

- The absence of formal meetings with management to agree the value of the benefits and costs identified.
- Expecting the management to establish the probability of the accuracy of the results and whether or not to proceed with the proposal, when they may not have been consulted on the value of the data input.
- Considering the evaluation on an investment basis (albeit including the benefits and costs on a company wide basis) and not on the effect the investment could have on the Company's finances as a whole - where the actual value could differ.
- No advice on identifying the business needs of a company - even if the investment meets the company's required IRR or NPV, is it beneficial to the Company's long term strategy?
- No method of advising companies of the new investments currently available, only the suggestion of undertaking post-audits - when it's too late.

## **4.5 Summary**

This Chapter has examined the non-traditional cost justification techniques and non- accounting based approaches.

The literature showed that probabilistic techniques, although subjective, often provide a clearer understanding of the interaction of the elements, by identifying the sensitivity of an investment proposal to a particular factor. In placing a figure on future scenarios, due to the uncertainty involved and in the quantification of intangible benefits and costs, probabilistic techniques are invaluable. As such, they should be viewed as a component of a cost justification technique.

The emphasis by the Japanese on developing easy to understand management and accounting tools is reflected in the willingness of their accountants to work with Research and Development, Design, Engineering and Marketing departments.

Whilst many Japanese companies use Payback Period in justifying investment in rapidly changing manufacturing environments, they do incorporate intangible benefits which could make the Payback Period shorter than in the West. Also, they do make use of ROS and Asset Turnover as performance measures. ROS, it is claimed [45], assists them in reducing their product costs without sacrificing quality. In the West, ROS is also used as a measure of the efficiency of a company, a high ROS indicates that either costs are being kept well under control or that sales prices are high [50]. The Japanese use Asset Turnover to relate sales turnover to the capital employed. If the Asset Turnover can be increased, this indicates larger profits can be made without increasing the size of the investment.

It is suggested by Sakurai [45] that the low application of ROI is due to the fact that ROI can be broken down into ROS and Asset Turnover, thereby overcoming the disadvantages of ROI and gaining the benefits of ROS and Asset Turnover.

It is the belief of the author, that the Japanese have realised the value of Payback Period, ROS and Asset Turnover. If Payback Period were to be used to justify investments in terms of time and to indicate the level of risk, ROS to ensure costs were kept under control and Asset Turnover to gauge the profitability of the investment over the time period, then these three methods would be used to their best advantages.

Unfortunately the Cost of Quality Schedule (COQS) is limited in its application because it is not an accepted accounting technique. However, it could be useful in quantifying the intangible benefits, as it encourages analysis of the processes within a company.

The headings, such as, lost opportunities, internal failure, external failure, exceeding requirements, appraisal and prevention, could form part of the rules for pointing the user to possible technologies, but this would necessitate pre-determining the Actions as design changes, tooling modifications, etc., which would limit the effectiveness of the schedule by limiting analysis of the processes of a company. Also, not all Actions would relate to every company.

The strengths of IVAN include its recognition of the importance of intangible benefits in cost justification, its capability to quantify the intangible benefits identified, the use of three scenarios to increase the validity of the results and its recommendation that the quantified value will be in the range of a value and not a precise figure to two decimal places.

IVAN's disadvantages include, its reliance on traditional cost justification techniques, namely ROI, NPV, IRR, its inability to consider the effect of doing nothing, its lack of formal meetings with management to decide the values of the data input and ignoring the business needs of a company.

## **Chapter 5.0 The Finjust Methodology**

### **5.1 Introduction to Finjust**

Finjust, supported by a Department of Trade and Industry grant over a fifteen month period, involved the collaboration of three companies to develop an adaptation of the Profit and Loss Account, identified by Mundy Johnson, into a usable, new cost justification methodology for companies considering investment in Computer Integrated Manufacturing.

The project was led by Quintec Systems, who were to be responsible for the development of the software, Mundy Johnson and Entrepreneurial Technologies Limited were to research, develop, test and improve the approach into a methodology.

The author of this thesis was responsible for linking the business needs to technologies and the identification of the benefits of the CIM proposals.

### **5.2 Overview of the Finjust Methodology**

The Finjust Methodology is based on the Profit and Loss Account and involves four key stages:

1. Modelling the Current Business.
  - Identify the key product groups of the business.
  - Build a profit and loss account model of the current business.

## 2. Match Business Need to an Investment Strategy.

- Set a target for growth of the business.
- Examine the business needs and potential areas for growth.
- Match the investments which will satisfy the business needs.
- Modify the model to reflect the effect of the investments.

## 3. Outline the Future Influences.

- Set up the expected, pessimistic and optimistic scenarios.

## 4. Plan the Future Reaction of the Business.

- Consider the future reaction without the investment.
- Consider the future reaction with the investment.
- Compare the future profit with and without the investment.

### **5.2.1 Modelling the Current Business.**

The Finjust methodology begins by requesting the user to input data regarding the Company name and the Product Families or Groupings to be audited.

Finjust recommends grouping products according to their key manufacturing similarities. This is achieved by looking at the technology used to carry out the manufacturing process. For example, take two products that use different manufacturing techniques - one manufactured by thermal injection of plastic, the other by metal pressing. Because the technologies are fundamentally different, then the business dynamics are also fundamentally different, i.e. waste levels would be substantially different, as would energy costs, raw materials, etc., and therefore, they should be grouped in separate families. However, if two products use the same technology in their manufacture, such as founding, then they would be considered as being similar and might be placed in the same product group no matter what product was being made.

Finjust restricts analysis to six product groups. It is recommended that only the most important five groups are considered individually, the sixth group, headed 'other', to be used for company wide costs and overheads.

Finjust's Consolidated Profit and Loss Account shows the financial status of the business at the current time, as represented by the five product groups and the 'other' column. The 'Total' column displays the consolidated total for each key item of income or expenditure.

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**Consolidated Profit and Loss Account**

Click on each entry to enter or edit detailed figures

	Group A	Group B	Group C		Other	TOTAL
<b>Income</b>						
Products	239276	1075200	44600			1359076
Services	43500	12055	11000			66555
<b>TOTAL</b>	282776	1087255	55600			£ 1425631
<b>Expenditure</b>						
Materials	83953	474580	31360			589893
Labour	75256	197663	16575			289494
Inventory	20988	118645	3136			142769
Finance					44056	44056
<b>Overheads</b>	4250	1406	8500		205500	219656
<b>TOTAL</b>	184447	792294	59571			£ 1285868
<b>Pre Tax Profit</b>					£	139763
<b>Return on Turnover</b>					%	10

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Figure 9 Finjust's Current Profit and Loss Account.

The consolidated Profit and Return on Turnover (ROT = Profit divided by Turnover multiplied by 100) are calculated by the model and shown at the bottom right hand corner of the account.

The Consolidated Profit and Loss Account involves the input of financial data for the product groups.



For each sub-factor the user can enter its current value, its minimum and maximum possible values and the External Influences that affect the sub-factor. As shown in Figure 10.

The screenshot shows a software window titled 'FINJUST - DEMO..XLS' with a menu bar (File, Edit, View, Tutorial, Options, Help) and a status bar (PgDn: Next Page, PgUp: Previous Page, F1: Help). The main content area is titled 'Group A : Without Investment' and 'Materials Cost per Unit'. It features a table with columns for Sub-Factor, Value, Constraints (Min, Max), and External Influences (Vol, MSh, Proc, Mat, Infl, Int). The table contains data for 'Raw Materials (£)', 'Bought Out Parts (£)', and '% Waste per Unit'. Below the table is a 'Formula' field containing 'Volume x ((Raw Materials x % Waste) + Bought Out)' and a 'Notes' field with the text 'Enter a comment to explain any of the above information'. A 'OK' button is located at the bottom center.

Sub-Factor	Value	Constraints		Vol	MSh	Proc	Mat	Infl	Int
		Min	Max						
Raw Materials (£)	17.66		25.6				x		
Bought Out Parts (£)	25.55	20	30				x		
% Waste per Unit	5	3							

Formula:

Notes:

Figure 10 Breakdown Screen for Material Costs.

The minimum and maximum constraints are optional and may be used to enter any known constraints which restrict the growth or reduction of a particular sub-factor. These constraints will be used later in the methodology when projecting future scenarios.

The External Influences are also used later in the methodology. Each External Influence the user considers has an effect on a sub-factor is marked by an "x" in the appropriate position. The Finjust model is supplied with a default set of External Influences for each sub-factor. If the user disagrees, the external influences can be readily changed.

The External Influences are:

- Vol = Global Market Volume.
- MSh = Market Share.
- Prc = Retail Price.
- Mat = Price of Raw Materials.
- Infl = Inflation rate.
- Int = Bank Base Rate.

On each input screen there is a box displaying the formula used to calculate the sub-factor. The formulas for calculating the value of the sub-factors are based on the following:

Product Sales Revenue =

Market volume x % Market share x Unit Price

Service Sales Revenue =

Training and Consultancy + Spares + Maintenance + After sales service +  
Two other unspecified options.

Material costs =

(Volume x Unit Raw Material cost) + (Volume x Unit Bought Out Parts cost)  
+ (%Scrap x Raw Material cost x Volume)

Labour costs =

Labour hours per unit x Cost per labour hour

Inventory costs =

% Inventory level

Finance costs =

Capital repayment + Interest repayment

Overheads =

Buildings + Rates and Rent + Services + Staff Salaries + Administration

### 5.2.2 Match Business Need to an Investment Strategy.

The second stage considers the movement of the business from its current position to some target of profitability through the consideration of its business needs. The target for growth is achieved by specifying a target profit or ROT for the business in the appropriate cells. See figure 11.

The screenshot shows a software window titled "Business Needs Analysis" with a menu bar (File, Edit, View, Tutorial, Options, Help) and a status bar (PgDn: Next Page, Pg Previous Page, F1: Help, NUM). The window contains a text box with instructions: "1. Specify target profit or ROT", "2. Enter a percentage increase/decrease.", and "3. Click on product labels to justify through investment". Below this, there are input fields for "To Achieve:" with "PROFIT" set to "180000" and "ROI" empty. A table for "Increased Sales" has columns for "Group A", "Group B", "Group C", and "Other", with rows for "Products" and "Services". A table for "Decrease Costs" has columns for "Materials", "Labour", "Inventory", and "Overheads", with "10" entered in the "Materials" and "Labour" cells. At the bottom, there are input fields for "Giving Improved:" with "PROFIT" and "ROI" empty.

To Achieve:	
PROFIT	180000
ROI	

Increased Sales				
	Group A	Group B	Group C	Other
Products				
Services				

Decrease Costs				
	Materials	Labour	Inventory	Overheads
	10			
		10		

Giving Improved:	
PROFIT	
ROI	

Figure 11 Business Needs Analysis.

The business needs and potential areas for growth requires specifying percentage improvements (based on the users knowledge of what the business

can achieve) on one or more cost or revenue factors for one or more product groups until the required target profit or ROT is matched. The calculations are completed automatically by Finjust.

The improvements specified must then be justified in terms of either possible investment in new technology and manufacturing strategies or through consequential changes in the operating breakdown of a factor.

The objective of matching the investments which will satisfy the business needs is to identify a suitable investment which will enable the business to achieve the target improvement for the appropriate factor. Finjust uses the following basic strategy:

If the business need is **Increase Sales Revenue**, then this can be achieved by:

- Reducing costs
- Reducing lead time
- Improving due date conformance
- Improving quality
- Improving functionality and features
- Increasing production capacity
- Improving customer service.

If the business need is **Reduce Costs**, then this can be achieved by:

- Reducing material costs
- Reducing labour costs
- Reducing inventory costs
- Reducing overheads.

As a working strategy, for each Product Group, first consider Product Design, If this is unacceptable, then consider Process Design and If this is unacceptable then consider Production or Materials Management.

Investment Options	
Product Group: Group A	
Business Need: REDUCE MANUFACTURING MATERIAL COSTS	
Reduce material costs through:	
<input type="checkbox"/>	Product design and customisation
<input type="checkbox"/>	Process Re-design
Reduce the direct costs associated with:	
<input type="checkbox"/>	Raw Materials
<input checked="" type="checkbox"/>	Bought Out Parts
<input type="checkbox"/>	Inspection and Test
<input type="checkbox"/>	Packaging and Delivery
<input type="button" value="OK"/>	

Figure 12 Investment Options.

Finjust only requests input from the user, where a value exists in a cell opposite a revenue or cost factor. For example, as shown in figure 11, Product Group A has a percentage decrease in material costs. Consequently, Finjust displays a screen, as in figure 12, requesting data on how the user expects to achieve the business need. Based on the users reply another screen appears (figure 13) suggesting possible Advanced Manufacturing Technologies (AMT's). For a brief explanation of the AMT, the user can select the description button. Finjust recommends that each option should be considered and researched in detail with advisors, suppliers and consultants. When the user is satisfied with the AMT, a value is entered under cost. The user then enters the amount to be financed and the percentage interest rate.

Investment Options														
Product Group: Group A														
Business Need: REDUCE COSTS OF BOUGHT OUT PARTS														
The following AMT solutions are suggested for detailed investigations. For each solution please enter an estimated capital cost.														
	Cost	Description												
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Vendor Rating Management Open Ordering from Suppliers Supplier Contract Renegotiation Procurement Engineering Electronic Data Interchange (EDI) Standard Products	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 10px; text-align: center;">£</td><td style="width: 50px;"></td></tr> <tr><td style="text-align: center;">£</td><td></td></tr> <tr><td style="text-align: center;">£</td><td></td></tr> <tr><td style="text-align: center;">£</td><td></td></tr> <tr><td style="text-align: center;">£</td><td></td></tr> <tr><td style="text-align: center;">£</td><td></td></tr> </table>	£		£		£		£		£		£	
£														
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£														
<input type="button" value="OK"/>														

Figure 13 Investment Options - Solutions.

Having identified an appropriate AMT, costed the investment and specified how it will be financed, it is necessary to enter the consequential benefits and ensure the target profit or ROT have been achieved. This is done by entering data onto screens similar to those used to input the current Sales Revenue and Cost data.

The effect the investment could have on the current financial status of the business, can now be seen on the Consolidated Profit and Loss Account - With Investment.

### 5.2.3 Outline the Future Influences.

The following stages in the Finjust methodology proceed to build a model of the future for the business and show the difference in possible profitability with and without the investment.

The first stage is the input of data for the expected, optimistic and pessimistic scenarios. The scenarios relate to external influences - that is, influences outside the control of the business. Simply projecting the consolidated profit and loss account with investment would fail to consider the changes that are inevitable on a global scale, thereby, distorting the view of future benefits.

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### Future Business Scenarios

Enter estimates of how the following external factors influencing the business will change for pessimistic, expected and optimistic future conditions.

Business projection for  years

Factor	Pessimistic	Expected	Optimistic	
Global Volume	-2.00	1.00	5.00	% change pa
Market Share %	-1.00	2.00	4.00	% change pa
Ave. Sales Price	4.00	4.00	5.00	% change pa
Raw Material Cost	4.50	3.50	2.00	% change pa
Inflation %	5.00	3.50	2.00	% rate pa
Base Rate %	12.00	10.00	8.00	% rate pa

↓ ↓ ↓

Projected Profit if no action is taken	-42506	346089	966423	£
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PgDn: Next Page    Pg: Previous Page    F1: Help    NUM

Figure 14 Setting the Future Business Scenarios.

The types of external influences are pre-determined by Finjust as shown in figure 14. They are:

- Global Volume - changes in demand by the customer for the Product Group.
- Market Share - actions of new or aggressive competitors.
- Average Sales Price - change in the price structure of the Product Group by all or most of the manufacturers.

- **Material Costs** - caused by fluctuations of demand, supply or availability.
- **Inflation Rate** - direct effect on salary structures and labour costs, indirect effect on materials, equipment, sales price, customer buying power, etc.
- **Base Rate** - effects the cost of borrowing, the return on investment expected by shareholders, etc.

The number of years for which Finjust can calculate the effect of external influences is set at five, but the user can reset this to any figure. The effect if no action is taken by the business is shown at the bottom of the screen. This allows the user to judge whether the figures entered for the scenarios are truly representative.

#### **5.2.4 Plan the Future Reaction of the Business.**

The future reaction without the investment displays the effect if **no** action is taken for each of the three scenarios. At this point, the user can select each of the product groups and adjust the constraints, entered in the first model, to reflect the forecasted outcomes.

The future reaction with the investment displays the effect if **action is** taken, for each of the three scenarios. At this point, the user can select each of the product groups and adjust the constraints, entered in the first model, to reflect the forecasted outcomes.

The final section allows the user to compare the Future Profit and Loss Accounts for all three scenarios, with and without the investment. A graphical display can also be selected if required.



### **5.3 Critique of the Finjust Methodology**

The critique discusses the advantages and disadvantages of the Finjust Methodology.

The advantage of viewing a company's financial status on the basis of its product groups, is that it relates sales revenue and costs to particular activities involved in the production of each product group. Also, it shows the effect, changes to those product groups will have not only on each product group, but on a company as a whole.

However, the main advantage for Product Grouping, as defined by Finjust, is to avoid the whole process becoming unnecessarily complicated in terms of the sheer volume of data that would need to be considered. A valid point.

Unfortunately, to overcome this problem, Finjust recommends grouping products according to their key manufacturing similarities.

The use of key manufacturing similarities, although plausible for single process products, runs into difficulty when considering products that include multiple processes, for example, a fan heater - moulded plastic casing, pressed metal fan, electronic sub-assemblies and electric heating elements. Under such circumstances the use of key manufacturing similarities would seriously hamper analysis of a company's product range.

In addition, when companies consider Product Family sales - in either value or volume, they generally refer to Sales Product Families and not those based on manufacturing processes. Sales Product Families being similar products that are sold to a particular set of customers.

The Finjust methodology states that they can only encourage companies to adopt the key manufacturing similarities concept and, consequently, do allow companies to use their own product grouping methods. However, as the methodology is based on the key manufacturing similarities concept, some companies may be left wondering how the methodology will react to those companies who choose their own methods to define product families. Unfortunately, no reassurance is provided on this point.

The main advantage of breaking the Sales Revenue and Cost Factors of the Profit and Loss Account into their constituent parts, is that it increases the opportunity for making changes later on in the methodology. For example, material costs are calculated by multiplying raw material cost by the volume of products sold. Having identified future savings in raw materials as a benefit of re negotiating supplier contracts, the material cost for one or more product groups can be reduced to the new value by simply changing the value in the raw material cell.

The disadvantages with such an approach, lies in the equations used to calculate the sales revenue and cost factors and the lack of assistance provided in guiding the user.

In calculating the product sales, the methodology requires the company to know the market volume for all their product families and their percentage share of each market. It is highly questionable that precise information would be available and, therefore, the user would have to rely heavily on estimated data. The use of actual sales volume data for product families would be considerably easier to obtain and be more accurate, yet, because the methodology does not allow the user to change the formula for calculating product sales, the user companies are forced to collect additional estimated and possibly unreliable data, without any advice on how to go about it.

Service sales revenue could be considered as a separate sales product family, this would overcome the risk of making subjective judgement when allocating training, consultancy work and after sales service revenue to specific sales or process product families. However, by providing two unspecified options it could be assumed that a lump sum could be placed under service sales to cover unidentified but product family related revenues. There is no assistance provided on how the 'open' two options should be completed.

The 'volume' is taken from the product sales revenue screen for each product family and, apparently it is not considered necessary to display it again. However, the volume produced may not equal the volume sold, leaving the user unable to alter the value. This situation could adversely affect the rest of the analysis through inaccurate product costing. Once again no advice is available to assist the user in specifying unit raw material and bought out costs or % scrap.

Although the calculation for the labour cost of a product is an accepted method, where users who have adopted other direct labour costing methods they must change to this method, as the formula is pre-set.

The percentage inventory level would benefit by being broken down into obsolete inventory and average percentage inventory over a specific time period. This would facilitate identifying the future benefits possible in the implementation of techniques, such as, Just In Time (JIT) and would help users to recognise the importance of accurate data on inventory. For example, when a company alters a product already in production, forcing the purchase of a new alternative component, does that company cancel the purchase of the old component?

Finance costs are normally included under Expenses in the profit and loss account and, subsequently, refer to company wide costs and not to product

specific costs as indicated by Finjust. No help is provided to explain to the user that the finance costs, probably relate to past improvement, upgrade, expansion, etc., programmes which have already taken place. The option to input an all inclusive figure should be provided for. An explanation of the terminology could also benefit some users.

Overhead allocation based on product families, whether sales or process oriented, frequently lacks objectivity and is therefore open to question. A user unfairly allocating overheads could provide a misleading view of the profitability of some of its product families. For example, product family A, being a mature product, has overheads of £500 per annum, product family B - a new product - includes a proportion of the cost of design and development, bringing its overhead allocation to £9,000. At first appearance it would appear that product family B should be terminated. Only after consideration of the company wide overheads, could it be proven that product B was in fact providing a substantial contribution to the overheads, enabling any injustice in the apportionment of overheads to product family B be identified.

#### **5.4 Summary**

The Finjust methodology offers many improvements over the traditional and non-traditional approaches examined earlier. Not least, that it is based on accepted accounting techniques - the Profit and Loss Account - which is the universally accepted model of the trading activities of a business. Nonetheless, the methodology developed as part of the Finjust project is limited in scope and lacks a number of important analyses. In addition the Finjust methodology contains many inconsistencies in the choice of units used to build the financial model and, perhaps, most important, it fails to provide a mechanism by which the participation of staff in the financial appraisal process can be secured. Such participation is essential if investments are to be implemented effectively.

With respect to the limited scope, Finjust does not allow for the calculation of any of the traditional methods of cost justification, such as, Payback Period, Break Even Analyses, ROI, NPV, IRR, etc., denying users the chance to compare results. Nor does it allow users to fund investments at different rates of interest, for different time periods. Finjust does not facilitate the entry by the user at different stages, nor does it offer multiple evaluation options. Finjust only offers the user one option, that of identifying and justifying possible investments. Business needs of a company cannot be selected by the company, they are automatically calculated by the software. Such actions prevent companies from undertaking:

1. Selection of business needs.
2. Identification of possible investment(s) for specific business needs for a company.
3. Evaluation of known investments.

The advantages of Finjust lie with the identification of a 'base line' for quantifying and checking the value of the benefits and costs associated with an investment over a period of time. The use of scenarios depicting the optimistic, expected and pessimistic outcomes in the future, with and without the proposed investment, improve the credibility of the future values.

Finjust's ability to recommend possible investments is not offered by any other financial justification or evaluation techniques. Analysis is considered by other techniques on an investment basis, some including the 'company wide' benefits, but no other technique considers the effect an investment has on the 'company wide' financial status of a business.

By addressing the disadvantages, errors and inconsistencies, the Finjust project could be adapted to form the basis for a radically new approach to the cost justification of new manufacturing technologies.

## **Chapter 6.0 Financial and Costing Systems in Manufacturing**

### **6.1 Introduction**

In order to develop a new approach to justify manufacturing investments it is essential that the financial and costing systems currently used in manufacturing are understood and the data and information likely to be available identified. Without knowledge of the nature and type of information and data available it would be impossible to develop a practical system.

The cost factors that constitute an overhead varies amongst companies. An overhead that is fixed for one company, can be a variable overhead for another [50]. This lack of definition can even occur between different departments or functional areas within a company. The problem of overhead definition is further complicated by the difference of opinion held by companies as to which overhead should be allocated to Production and which to General overheads.

In addition, for a new financial justification to be acceptable, it must be compatible with the financial systems currently used by manufacturing companies. To illustrate this point, the representation of both product specific and company wide sales and cost data in unconventional format is liable to be rejected by the user.

### **6.2 Financial Accounting Systems**

The main financial accounting systems employed by companies are the Trading Account, the Profit and Loss Account, the Appropriation Account and the Balance Sheet [23], [50]. Many companies incorporate into the Profit and Loss Account

the Trading Account and where a company does not have shareholders there is no need for the Appropriation Account.

Conversely, the Profit and Loss Account can be expanded to incorporate a Manufacturing and/or Assembly Account. By detailing the costs involved in the manufacture and/or assembly sectors of a company, managers can identify high cost or non-value adding activities. However, there is the danger that by concentrating on the manufacturing sector, any benefits gained from investment in new manufacturing technologies will only be sought in the area of implementation and not in the company as a whole. The expenses or general overheads can also be expanded to represent the financial impact each department within a company has on the company as a whole. This too can be an unwelcome benefit, analysis of individual departments can lead to inter-department rivalry which is not always in the best interests of a company as a whole [51].

### **6.2.1 Trading, Profit and Loss and Appropriation Account**

The Trading, Profit and Loss Account and the Appropriation Account represents the trading situation over a fixed period of time, as shown in figure 15.

The Trading Account shows the sales revenue for the period, the cost of producing the products sold and the company wide expenses.

To calculate the Net profit, in the Profit and Loss Account, the Trading Profit for the Year is carried forward and the cost of interest and the Corporation Tax are deducted.

The Appropriation Account displays the Net Profit, less payments to shareholders, plus the unappropriated balance brought forward, thereby



calculating the unappropriated balance to be carried forward to the Balance Sheet and entered under Reserves.

<b>Trading, Profit and Loss Account 1/9/92 to 31/8/93</b>	
<b>Trading Account</b>	
Sales	300000
Less: Cost of Goods Sold	212000
Gross Profit	88000
Less: Selling & Administration Expenses	20000
<u>Trading Profit (Loss) for Year</u>	<u>68000</u>
<b>Profit &amp; Loss Account</b>	
Trading Profit for Year	68000
Less: Interest on Loan	8000
	60000
Less: Corporation Tax	20000
<u>Net Profit (Loss)</u>	<u>40000</u>
<b>Appropriation Account</b>	
Net Profit for Year	40000
Less: Ordinary Dividend	10000
Retained out of Years Profits	30000
Add: Unappropriated Balance Bought Forward	10000
<u>Unappropriated Balance Carried Forward</u>	<u>40000</u>

Figure 15 Trading, Profit & Loss and Appropriation Accounts [23].

## 6.2.2 The Balance Sheet

The Balance Sheet is a statement of a company's assets and how they have been financed at one point in time. As shown in figure 16, the Balance Sheet incorporates financial information gained from the Profit and Loss Account. Although the Balance Sheet displays the profit or loss, the capital employed, etc., it does not provide sufficient detail for managers to exercise financial control effectively. Managers need to know how much income has been earned, what

various items of costs have been, and whether the performance of sales or the control of costs appears to be satisfactory [50]. Neither does the Balance Sheet provide sufficient detail to assist in the cost justification of new manufacturing investments. For example, it provides no information on the time value of money, how much profit or loss an investment might make in the future, where the benefits and costs of an investment might occur within the Company nor does it relate the profit or loss to the sales turnover.

<b>Balance Sheet for Company B on the 31/8/93</b>		
Share Capital:		
200,000 Ordinary Shares @ £1		200000
Reserves:		
Profit & Loss Account Balance		40000
		<u>240000</u>
Long Term Liabilities:		
Loans		40000
		<u>40000</u>
	Capital Employed	<u>280000</u>
Fixed Assets:		
Buildings	80000	
Plant	70000	
Vehicles	10000	
		<u>160000</u>
Current Assets:		
Inventory	80000	
Debtors	70000	
Cash	30000	
		<u>180000</u>
Less Liabilities:		
Creditors	30000	
Ordinary Dividend	10000	
Corporation Tax	20000	
		<u>60000</u>
Net Current Assets (Working Capital)		<u>120000</u>
	Net Assets	<u>280000</u>

Figure 16 The Balance Sheet [23].

### 6.2.3 Manufacturing, Trading, Profit and Loss Account.

<b>Manufacturing, Trading, Profit and Loss Account for Year Ended 31/8/93</b>		
<b>Manufacturing Account</b>		
Opening stock of raw materials		3000
Purchases		<u>108900</u>
		111900
Closing stock of raw materials		<u>3300</u>
Raw materials used in production		108600
Direct labour		<u>186520</u>
Prime Cost		295120
<b>Manufacturing Overheads:</b>		
Depreciation of equipment	8000	
Depreciation of Buildings	900	
Rates	2420	
Energy	4000	
Other expenses	<u>1250</u>	
		<u>16570</u>
Manufacturing costs during year		311690
Plus opening stock of WIP	3000	
Less closing stock of WIP	<u>4000</u>	
Change in WIP		<u>(1000)</u>
Cost of finished parts produced, (C/F to Trading Profit & Loss Account)		<u><u>310690</u></u>
<b>Trading, Profit &amp; Loss Account</b>		
Sales Revenue:		
Of finished parts		520000
Other sales		<u>7000</u>
Total Sales Revenue		527000
Opening stock of finished parts	18000	
Cost of finished parts produced	<u>310690</u>	
		<u>328690</u>
Closing stock of finished parts	<u>22000</u>	
Cost of Parts Sold		<u>306690</u>
Gross Profit		<u><u>220310</u></u>
Expenses:		
Salaries	154500	
Overheads	27000	
Finance costs	8500	
Other	<u>4510</u>	
Total Expenses		<u>194510</u>
<b>Net Profit (Loss)</b>		<u><u>25800</u></u>

Figure 17 The Manufacturing, Trading, Profit and Loss Account [50].

Where companies have expanded the Trading, Profit and Loss Account to include a Manufacturing Account, details relating to raw material inventory, raw material purchases, direct labour, manufacturing overheads and work in progress can be incorporated with details of sales revenue, finished goods inventory and expenses. By increasing the detail a company can readily view changes to the financial status on a company wide basis, as shown in figure 17.

The Manufacturing Account can be further expanded to include details of assembly operations, through the use of an Assembly Account. The opening and closing stock of raw materials being replaced by the opening and closing stock of bought out parts. Purchases then represent the cost of finished parts produced in the manufacturing department and parts bought from outside suppliers. Where the manufacturing and assembly operations are housed on the same site or in the same building, the overheads require dividing between the two departments. Work in progress would be related to each individual department. The cost of finished parts produced would then be represented by the finished goods assembled and this value would be carried forward to the Trading, Profit and Loss Account.

### **6.3 Overheads**

The categorisation of overheads plays an important part in the identification of product family costs. Without accurate and representative sales product/product family costing, a company cannot be certain whether the products it is selling are contributing to the profitability of the company or depleting its profits.

The difficulty involved in identifying and quantifying overheads is largely dependent on the number of products produced by the company. Where only one product is produced, allocation of overheads is relatively simple. If for example, a

company has overheads of £4000 and produces 1000 identical products, then the overheads for each product can be easily determined by dividing the overhead cost by the number of products, i.e.  $4000/1000=£4$ . Were the company to introduce further products using the same equipment as the original product, how would it decide on the allocation of overheads? Should it base its calculations on volumes, time taken, labour content, space utilisation or possibly a combination of these factors?

### **6.3.1 Manufacturing Overheads**

Manufacturing overheads are the total manufacturing costs that cannot be directly traced to a specific product. Examples of manufacturing overheads include, energy consumption, maintenance and repair, buildings, manufacturing supervisors and managers, equipment, plant and machinery [52]. For example, a company manufactures spin dryers, washing machines, freezers and refrigerators. The freezers and refrigerators use the same electric motors. The spin dryers and washing machines both use different types. The refrigerators represent a product range improvement for the company and are, due to space constraints, partly manufactured at the freezer site and then finished at the spin dryer site, which also assembles all the products. Maintenance and repairs are undertaken by one team who visit both sites as necessary.

In such a situation if the company needed to specify the overhead costs for each sales product it would have to calculate the energy used at two different sites and devise a method for splitting the cost between manufacturing and assembly, calculate the wages for the supervisors and managers, identify how much energy was used to manufacture each part, in order to calculate the cost for each sales product and agree on how to apportion building depreciation costs among the sales products.

### 6.3.2 General Overheads

General overheads are the total costs, less those costs attributed to manufacturing overheads, that are not directly related to a specific product.

Examples of general overheads include, but are not limited to:

- Salaries of Senior and Middle Management.
- Research and Development.
- Finance and Accounts
- Administration.
- Sales and Marketing.
- Materials handling.
- Personnel.
- Buildings.
- Equipment. etc

Unfortunately, there are many areas that are not distinctly defined as to what constitutes a manufacturing overhead or a general overhead and, therefore, a manufacturing overhead for one company could be a general overhead for another. To further complicate matters, both manufacturing and general overheads can be broken down into variable and fixed overheads.

Variable general overheads, for example, could be where the sales section required additional sales materials to cope with a new sales campaign, whereas fixed general overheads could be the cost of the sales section's building.

Variable manufacturing overheads, for example, would change with the volume of products manufactured, whereas fixed manufacturing overheads would remain constant no matter how many products were manufactured.

Again, a similar situation occurs when specifying fixed and variable overheads, an overhead that is fixed for one company could be regarded as a variable overhead for another. In an attempt to overcome the problem some accountants even suggest the use of mixed overheads [23], which far from clarifying the situation merely adds confusion.

#### **6.4 Costing Sales Products and Product Families**

Poor cost estimating and product costing result in an inaccurate cost, which in turn leads to an incorrect and often too low product price for certain product lines [24]. A company may not recognise this situation because their profitable products, which may also be inaccurately costed, but which are commanding a higher selling price, are supporting the others.

Where a company manufactures a wide variety of products, discrepancies can occur in the costing between complex and simple products. Under costing of complexity biases the decisions of design engineers and marketing managers in favour of designing and manufacturing more complex products than may be warranted [53]. Over costing simple products can make them appear unprofitable.

In calculating product costs, which costs should be included? According to Borden [54] "in looking at product cost measurement, a firm must realise that all costs - manufacturing, production, marketing, administration - are product costs".

In order to audit sales products and/or sales product families it is important to identify a representative costing mechanism which truly reflects the costs involved in the production of the sales product/product family, yet avoids all or the majority of costs based on estimates and assumptions.

The costing of product families falls into the following main approaches:

- Absorption Costing (total or full costing).
- Marginal Costing (direct or variable costing).
- Activity Based Costing
- Life Cycle Costing

#### **6.4.1 Absorption Costing**

Absorption costing was originally designed to ensure that all costs involved, not only in manufacturing, but throughout the company, were considered when costing products or product families [23]. Absorption costing was not designed primarily to provide accurate product costs, but to match costs and revenues for a given period of time.

The process involved in ascertaining sales product/product family costs using absorption costing requires the following stages:

1. Determine production overheads in terms of indirect materials, labour and expenses, using historical records, forecasted data for production and sales, inflation and growth rates, etc.
2. Identify and select cost centres. Commonly, cost centres are derived from departments, or sections or even individual machines. Assembly, Plating, Manufacturing, etc.
3. From the overheads and the cost centres identified, charge overheads to appropriate cost centres, where possible. For example, the cost of maintenance staff who work only on the assembly equipment would be charged to the Assembly Department.



4. Overheads that cannot be charged to a specific cost centre are apportioned using an agreed (but arbitrary) basis such as, floor area, number of employees, etc.
5. Determine costs associated with service departments and where appropriate, compare costs with outside contractors. Charge departments for the cost of the Service department based on some form of apportionment.
6. Identify method of overhead absorption or recovery rate. Common methods used are based on estimates for either the direct labour hours or the machine hours. The rates are determined by dividing the overhead costs for the cost centre by the estimated number of direct labour or machine hours for the cost centre. For example, if Product Family PF1 requires 2 hours of machining and the machine hour rate has been determined as £3.60, then the overheads charged to Product Family PF1 will be  $2 \times £3.60 = £7.20$ .
7. Determine if other expenses, such as, overheads for administration, marketing, sales, management, research and development, should be included in product costs and, if so, agree a method of charging them to specific product families.

The main concept associated with absorption costing is that because all costs are incurred solely to make possible the production of a product, as many as possible, of all the costs, should be allocated to specific products.

The disadvantages of absorption costing provide serious doubt to the use of absorption costing's suitability in product costing when cost justifying CIM.

The main disadvantages of absorption costing are its reliance on historical data, estimated future data and the apportioning of overheads to cost centres. Because

the first stage relies on future estimated data, should this data be incorrect, then subsequent stages will produce incorrect results. In the third stage, the overheads, which have been based on estimated data, are allotted to cost centres based on historical data and as such are only relevant while circumstances remain unchanged. Stage four requires apportioning the overheads which cannot be identified directly with a specific cost centre on an arbitrary basis. Even within the same company for similar overheads, the basis of apportionment can vary. The reasons for apportioning overheads to cost centres is subjective and, therefore, is liable to error.

Other disadvantages of absorption costing include determining the rate of absorption. No longer is it advisable to consider using labour hour rates to determine the absorption rate. Sakurai [55], states "direct labour hours allocation is only appropriate when products are produced by labour-paced processes." In companies moving towards CIM, direct labour often accounts for only 10% of product costs. With the reduction in direct labour and the increase in manufacturing overheads caused through the purchase of new equipment - resulting in higher depreciation costs, additional insurance, salaries for extra technical staff, companies who continue to assign overheads based on direct labour are liable to distort the true cost of their products. A possible scenario for companies in such a situation, could be the termination of a product family that is in reality providing a substantial contribution to the company's net profit, but appears to be making a loss due to the outdated product cost structure of the company. The use of machine hour rates overcomes the problem of labour hour rates, but machine hour rates as an absorption rate also poses problems, particularly, determining the time for processing a specific product at a cost centre. The maintenance of accurate and reliable time records then becomes essential, in order to minimise the errors likely to occur in estimating the time taken to complete a specific process. Also, is the time to be based on an average

time for the product or to include a percentage variance? Again subjectivity and personal bias may be involved.

Whether labour or machine hour rates are used, the fact that the rate is based on an estimate of the overheads and of the time involved, can only result in an estimated absorption rate. This estimated result must then be corrected in the Profit and Loss account, when the actual overheads are known. Unfortunately decisions made on the basis of the absorption rate might not be so easily resolved.

Time Period:	Sales Product/Product Families					
From:      To:	SP/PF 1	SP/PF 2	SP/PF 3	SP/PF 4	SP/PF 5	Totals
Sales Revenue:						
Finished Goods	1000	2000	3500	4500	1200	12200
Spares	600	400	500	1500	200	3200
Total Sales Revenue (TSR)	1600	2400	4000	6000	1400	15400
Costs Absorbed:						
Direct Materials	800	1200	2000	3200	750	7950
Direct Labour	150	250	400	650	150	1600
Manufacturing O/hs	70	120	140	485	125	940
Fixed Costs	150	160	100	1700	100	2210
Total Costs Absorbed (TCA)	1170	1730	2640	6035	1125	12700
Contribution (TSR-TCA)	430	670	1360	-35	275	2700
Fixed Costs Not Absorbed						700
PROFIT or (LOSS)						2000

Marginal Costing Contrib.	650	950	1600	2150	500	5850
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Figure 18 Example of Absorption Costing.

Figure 18 shows an example of five product families that have been costed using absorption costing and illustrates a further disadvantage associated with absorption costing techniques, that is, the distortion in the contribution that each product family appears to make to the profitability of the company.

From the example it would appear, at first sight, that the new Product Family 4 did not warrant introduction into the company's product range. However, a distortion

occurs in the contribution made (which have been included in Fixed Costs) by Product Family 4 as a result of apportioning research and development costs. While the other product families would have incurred research and development costs, they have not been apportioned with the same burden because they are mature products and the research and development costs associated with them are not known.

In Marginal Costing Product, Family 4 would be treated on the same terms as the other product families and, consequently, a more appropriate contribution is represented. To overcome the distortion, Absorption Costing under absorbs on new product families and over absorbs on mature product families. However, this yet again, calls for subjective decisions on determining the absorption rate for new and mature product families.

#### **6.4.2 Marginal Costing**

Marginal costing assigns only the variable costs, that is the costs which vary with the level of production, to the products, and fixed manufacturing costs are written off each year as period costs (costs based on time). Marginal costing attempts to redress many of the disadvantages associated with absorption costing.

Marginal costing involves the following stages [23]:

1. Identify and separate variable and fixed costs. Variable costs include direct labour and direct materials. Fixed costs include, rates, rent, salaries, etc.
2. Identify the variable costs relevant range, that is, a time period in which variable costs are unlikely to change due to forces other than variations in production. At certain levels of production the cost of materials could reduce due to increased order sizes or alternatively rise where small quantities are

required. Variable costs are also effected by external as well as internal influences. Increases in inflation could result in direct material costs rising.

- Identify the fixed costs relevant range, that is, the period in which fixed costs will not change for a given range of production. It is often assumed that fixed costs are fixed, that they can never change. This is not a true reflection of the real business world. For example, increased production can result in an increase in direct labour costs through bonus systems, or an increase in manufacturing space could increase rent and rates, thereby increasing fixed costs. Also, assets could be sold, resulting in a fall in fixed costs. Cooper and Kaplan [56] go further, by suggesting that fixed costs should be renamed long term variable costs, based on their observations that the most variable and most rapidly increasing costs were those that were traditionally classified as fixed.
- The contribution made by each product family can then be calculated using the method shown in figure 19.

Time Period:	Sales Product/Product Families					
From:            To:	SP/PF 1	SP/PF 2	SP/PF 3	SP/PF 4	SP/PF 5	Totals
Sales Revenue:						
Finished Goods	1000	2000	3500	4500	1200	12200
Spares	600	400	500	1500	200	3200
Total Sales Revenue (TSR)	1600	2400	4000	6000	1400	15400
Variable Costs:						
Direct Materials	800	1200	2000	3200	750	7950
Direct Labour	150	250	400	650	150	1600
Total Variable Costs (TVC)	950	1450	2400	3850	900	9550
Contribution (TSR-TCV)	650	950	1600	2150	500	5850
Fixed Costs (Overheads)						3850
PROFIT or (LOSS)						2000

Figure 19 Example of Marginal Costing

The advantages of using Marginal Costing are that product costs and inventory valuations consist of only identifiable costs, such as direct materials and labour.

The fixed costs are not included in the product family costing, but are offset in the Profit and Loss account. Marginal costing also overcomes the problem of subjective apportionment of overheads and absorption rates. Subsequently, the need to estimate under and over absorption rates for new and mature product families is removed. Fictitious profits cannot arise because the fixed costs are written off for the specific period under consideration, rather than being carried on in unsellable inventory. For planning and control purposes marginal costing clarifies the relationship between costs, volume and profit by identifying the contribution made by each product family. Finally, marginal costing is simple to use.

The disadvantages of Marginal Costing include the problem of identifying and categorising overheads into fixed and variable, as discussed earlier in the section on Overheads. Without distinct guidelines the selection of what constitutes which cost, fixed or variable, becomes a matter of subjectivity and prone to error. Marginal costing is also considered by many business accountants as a short term measure that is not suitable for long term applications because fixed costs vary over time.

### **6.4.3 Activity Based Costing**

Activity Based Costing (ABC) Systems have emerged where management decided that the fastest way to become more profitable was to gain a better understanding of what it cost to make their products [53]. ABC requires the identification of activities and their 'cost drivers', to allocate manufacturing overheads. Cost drivers measure a particular activity that adds costs to the product [57]. Cost drivers can be; set-up times, number of parts, direct labour hours, number of insertions, number of products not requiring rework, cycle time, supplier lead time, deviation from daily target production, etc. The use of ABC

allows the costs associated with the production of both complex and simple products to be accurately calculated.

Traditional costing methods tend to focus on the costs associated with a product after it has been designed. In manufacturing environments where product complexity significantly influences costs, a large proportion of the costs are determined at the design stage, although the cash flows that the accounting system monitor take place later [53]. Manufacturing complex products often requires additional supervision, quality control, inspection, maintenance, etc. Where product costing relies on direct labour or machine hours allocation, the product costs of a complex product will hide these additional costs. Product costs are therefore not 'true', leading to a bias towards the manufacture of complex products at the expense of simpler products, which in turn will affect the profitability of a company. ABC by identifying the cost drivers for a product, can map the costs throughout that product's manufacture. Also, by providing information on where costs reside in a product it allows the designer to consider alternative methods of manufacture or material, prior to manufacture.

In utilising ABC, it is not always necessary or desirable to use all of a product's cost drivers. If all possible cost drivers are used, the complexity of the product's costing becomes increasingly time consuming and complicated. Therefore, it is advisable to select only those cost drivers that contribute to most of the product's costs.

Advantages of ABC include: accurate product overhead allocation, this assists designers in the selection of manufacturing processes, and in considering alternative material choices for alternative processes, prevents over costing of simple products and the under costing of complicated products, encourages process and production engineers to identify cost adding - non value adding processes.

Disadvantages of ABC include the over complication of product costing through the identification of all cost drivers, the over simplification of cost drivers, the loss of ownership of processes due to cost drivers including additional activities, the incorrect identification of cost drivers and the incorrect charging rates for cost drivers.

#### 6.4.4 Life Cycle Costing (LCC)

Life cycle costing (LCC) is also referred to as product life cycle costing, total life cycle costing and the consumer to consumer cycle [58]. The concept of LCC is to cost a product over its entire life by identifying all the functions which add cost to a product, currently and in the future using present value techniques [28].

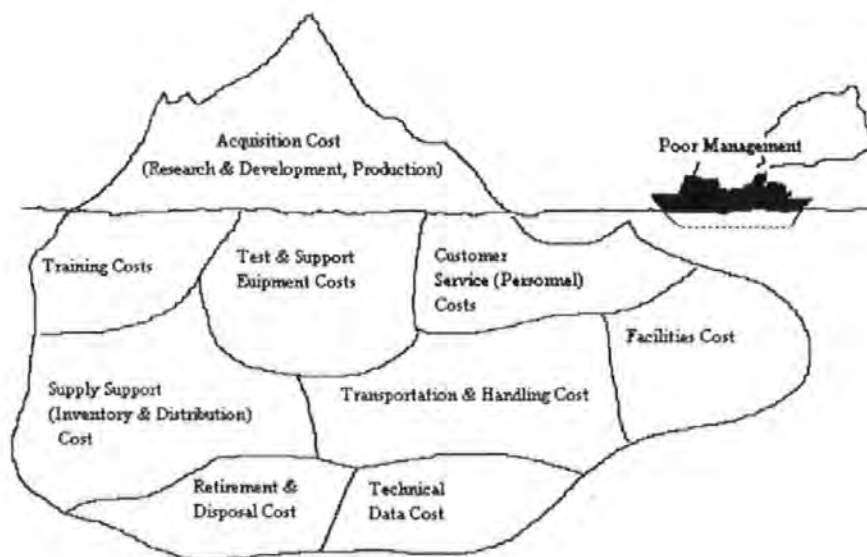


Figure 20 Life Cycle Costs [58].

LCC covers all the costs associated with a product over its entire life [59], such as, research, design, development, production, testing, packaging, supply and delivery, after sales service and warranties, modifications and upgrades, product retirement and material disposal [58], as can be seen in figure 20.



The LCC for a given product is determined by identifying the functions in each phase of the life cycle, costing the functions, applying the appropriate costs by function on a year to year schedule and then accumulating the costs for the entire span of the life cycle.

As all the costs associated with the life cycle of a product may be difficult, if not impossible, to predict and measure, LCC emphasises restricting costs to those that can be directly attributed to the product, that is, all direct costs.

The advantages of LCC includes: Developing an understanding of where costs reside in a product over its life span, thereby, providing management with an insight into where future cost reductions could be possible: Providing the opportunity to re-design a product to avoid future non-value adding costs: Improving the management decision process in identifying new product introductions: Provides information that enables the setting of variable product price structures for a product over its life to optimise profitability.

The disadvantages of LCC include: By forecasting possible future scenarios much of the LCCs are subject to conjecture and subjectivity, allowing personal bias: The risk of incorrect forecasting, the longer the life cycle the less likely the accuracy of the cost data: Use of cost data from similar products may not be relevant to a particular product: Errors may occur in the interpretation of the cost data, in cost estimating procedures and relationships and in applying the most appropriate costing technique.

## **6.5 Summary**

The main financial accounting systems of a manufacturing business, that is, the Manufacturing, the Trading, Profit and Loss and Appropriation accounts and the

Balance Sheet, have been described. These systems should, if designed and implemented correctly, provide management with the necessary information to identify where costs reside.

In considering the allocation of costs a number of product costing methods were examined; Absorption, Marginal, Activity Based and Life Cycle costing. All involved a degree of subjectivity in the allocation or apportionment of overheads. From this analysis it is clear, that any new approach to cost justification must overcome the problem of distinguishing between fixed and variable costs, as well as manufacturing and general overheads.

Utilising the same data and information used to construct the Manufacturing, Trading and Profit and Loss Accounts together with forecasts of future trading conditions, management could undertake a rigorous financial justification and assess the impact of potential investments on a company wide basis. By breaking the information down into product specific detail in the manufacturing account, such as, the sales revenue and the cost of sales, this type of account could provide a true representation on both a company wide and product specific basis.

## **Chapter 7.0 Deficiencies of Current Cost Justification Techniques**

This Chapter examines the deficiencies of the traditional and the non traditional cost justification techniques. This process will allow the requirements for a new cost justification methodology to be specified in Chapter 8.

### **7.1 Results of Comparisons**

Figure 21 displays a list of the deficiencies as numbered in the chart comparing the deficiencies of the different cost justification techniques, as shown in figure 22. The results of the comparisons of current cost justification methods are described below:

#### **7.1.2 Deficiencies 1 to 3.**

1. Fails to calculate time period required to recoup investment.
2. Fails to calculate value of sales to recoup investment.
3. Fails to calculate volume of sales to recoup investment.

Payback Period and Equivalent Maximum Investment Period are the only methods that directly calculate the time required to recoup an investment. The 'return' methods do provide an indirect figure for the time required, but this figure is dependent on other factors, such as, the rate of interest charged, and, therefore, these methods have been seen as being deficient in this area. Only the two Break Even methods inform the user of a figure for either the value or volume of sales required to recoup the investment. The value to a business of knowing the time, value and/or volume required to recoup an investment is useful where product life cycles are short or sales volumes are unreliable.

1	Fails to calculate time period required to recoup investment.
2	Fails to calculate value of sales to recoup investment.
3	Fails to calculate volume of sales to recoup investment.
4	Fails to identify profitability of each product in a high variety environment.
5	Methods that fail to recognise the changing product cost structures of today's businesses.
6	Overhead allocation that fails to specify precisely the difference between fixed and variable costs or manufacturing overheads and expenses.
7	Ineffective where future sales volumes are unreliable.
8	No profit or loss after cost of investment has been recovered.
9	Reliance on estimated data.
10	Use of hurdle rates.
11	Failure to advise on the 'Cost of Doing Nothing'.
12	Failure to consider the effect of 'Company Wide' costs and benefits on an investment.
13	Failure to consider the effect an investment has on a company as a whole.
14	No advice on identifying intangible benefits and costs on a 'Company Wide' basis.
15	No graphical representation.
16	Not the easiest to understand and/or use.
17	Methods that fail to suggest investments.
18	Methods that fail to define new acronyms.
19	Methods that fail to identify business needs.
20	Methods that fail to check feasibility of investment for business.
21	No formal meetings to enter data and/or agree actions.
22	Failure to recognise effective use of capital.
23	Incapable of identifying future working capital/investments needs.
24	Ineffective where multiple cash outlays occur.
25	No time value of money.
26	Profits not referred to capital.
27	Inapplicable for comparing investments.
28	Methods that are not based on sound accounting principles.
29	Reliance on subjective reasoning.
30	Unfamiliar methods for calculating sales revenue and cost factors.
31	Distortion of results when capital investment is large in the future.
32	Meaningless results when capital investment fluctuates frequently.
33	Meaningless results when cash flows are initially high then negative.
34	Refusal to invest due to large capital outlay.

Figure 21 Key to Numbers on Comparison of Deficiencies Chart.

Method:	Deficiencies:																																		Total				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34					
PP		•	•	•	•	•		•		•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•											34		
BEA	•			•	•	•	•		•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•			•								23		
BEG	•			•	•	•	•		•		•	•	•	•		•	•	•	•	•	•	•			•			•									19		
NPV	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•	•			•									•		23		
IRR	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•					•			•		•		26		
ROI	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•					•	•	•					26		
CB	•	•	•	•	•	•		•	•		•	•	•	•	•	•	•	•	•	•	•	•				•	•											21	
BCR	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•													23	
EAV	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•														22	
EY	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•											24	
EMIP		•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•												22	
CBA	•	•	•	•	•			•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•									25	
SA	•	•	•	•	•	•		•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•									26	
MCS	•	•	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•	•	•		•	•									26	
ROS	•	•	•		•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•															19
AT	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•															22
COQS	•	•	•	•	•			•	•	•	•		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•									26
IVAN	•	•	•	•		•	•	•	•	•		•		•	•	•	•		•	•	•	•	•	•	•	•												21	
P&L	•	•	•	•		•				•			•	•	•	•	•	•	•	•	•	•	•		•											•		17	
Finjust	•	•	•	•		•		•								•						•	•		•										•			11	

PP	Payback Period	ROI	Return On Investment	EIMP	Equiv. Max. Invest. Period	AT	Asset Turnover
BEA	Break Even Analysis	CB	Cash Budgets	CBA	Cost Benefit Analysis	COQS	Cost of Quality
BEG	Break Even Graphical	BCR	Benefit Cost Ratio	SA	Sensitivity Analysis	IVAN	IVAN
NPV	Net Present Value	EAV	Equivalent Annual Value	MCS	Monte Carlo Simul.	P&L	Profit & Loss Account
IRR	Internal Rate of Return	EY	Extended Yield	ROS	Return On Sales	Finjust	Finjust

Figure 22 Comparison of Deficiencies of Cost Justification Techniques.

### 7.1.3 Deficiencies 4 to 10.

4. Fails to identify profitability of each product in a high variety environment
5. Methods that fail to recognise the changing product cost structures of today's businesses.
6. Overhead allocation that fails to specify precisely the difference between fixed and variable costs or manufacturing overheads and expenses.
7. Ineffective where future sales volumes are unreliable.
8. No profit or loss after cost of investment has been recovered.
9. Reliance on estimated data.
10. Use of hurdle rates.

Of all the methods compared, only ROS was effective in identifying profitability for individual products. IVAN and Finjust, as new methods, made allowances for the changing product cost structures applicable in current manufacturing companies. Due to the data required in the Profit and Loss Account, changes in product cost structures were automatically reflected by this method. In specifying which overhead should be expressed as fixed, which as variable, which as manufacturing and which as company wide, the methods that were not deficient, did not require the breakdown of overheads in their calculation. Methods that required a 'return' were most at risk from unreliable future sales volumes. Break Even Graphical, Equivalent Annual Value, the Profit & Loss Account and Finjust addressed the deficiency of not identifying the profit or loss after repayment of the investment. In the use of estimated data the Payback Period and the Profit and Loss Account were exempt. The 'return' methods were included in this deficiency, because the 'return' is to a degree estimated. That is, a company may know the 'return' it requires, but it could include a risk rate, to cover against uncertainties. The use of 'Hurdle Rates' was applicable to all methods that produced a figure, such as, 25%, 2 years, 10,000 units, etc. Both the Profit & Loss and Finjust, could

be adapted to provide 'hurdle rates', for example, through the use of net profit. However, they were considered exempt from this deficiency as this is not a typical current practice.

With product cost structures changing, it is important to be able to identify the overhead allocation to products, to maintain the profitability of the company. It is insufficient to ascertain whether an investment will recover its cost, the amount of income generated must be considered for the long term growth of the business.

#### **7.1.4 Deficiencies 11 to 14.**

11. Failure to advise on the 'Cost of Doing Nothing'.
12. Failure to consider the effect of 'Company Wide' costs and benefits on an investment.
13. Failure to consider the effect an investment has on a company as a whole.
14. No advice on identifying intangible benefits and costs on a 'Company Wide' basis.

All methods, except Finjust, ignored the Cost of Doing Nothing, that is, the effect not investing could have on the business. The Profit & Loss Account, Finjust and IVAN do consider the effect that 'Company Wide' costs and benefits have on an investment, but, IVAN does not consider the effect the investment could have on the business as a whole. Only the Profit & Loss Account and Finjust addressed this deficiency. The identification of intangible benefits was only addressed by the new methods, namely, IVAN, COQS and Finjust.

It is also important to identify the current financial status of the business in order to compare expected future savings with the actual savings that occur in the future - the Cost of Doing Nothing forms the basis for such analysis. In justifying an investment, it is important to understand the effect that investment could have

on the business as a whole, and not just, the value of the 'Company Wide' cost and benefits as they affect the investment. The analysis of an investment on a company as a whole, would provide information regarding reduced profits or even losses. On an investment basis such effects would not be identified.

#### **7.1.5 Deficiencies 15 to 16.**

15. No graphical representation.

16. Not the easiest to understand and/or use.

Break Even Graphical, Monte Carlo Simulation and Finjust all provide a graphical representation of data. Monte Carlo Simulation displays the results of data as a distribution, the other two methods display graphs. In comparing methods on the basis of not being the easiest to use or understand, all methods except Payback Period, Break Even Analysis, IRR and ROI, met the criteria. The easiest to understand and/or use were limited to Payback Period, Break Even Analysis, IRR and ROI.

Graphical representation can aid in the understanding of the effect of an investment. According to the Japanese, the easier to use or understand a method is, the greater its likelihood of success.

#### **7.1.6 Deficiencies 17 to 21.**

17. Methods that fail to suggest investments.

18. Methods that fail to define new acronyms.

19. Methods that fail to identify business needs.

20. Methods that fail to check feasibility of investment for business.

21. No formal meetings to enter data and/or agree actions.



Finjust was the only method that addressed the deficiencies regarding failure to define new acronyms, words and processes, suggest investments, identify business needs and check the feasibility of investments. None of the methods used formal meetings to enter data and/or agree actions.

Not all companies are aware of the plethora of investments suitable, unless they contact outside consultants. Finjust addresses this dilemma by suggesting possible investments for further analysis. In suggesting new investment, it is imperative that companies understand the meaning of new acronyms. Many types of investment in manufacturing have been shortened to acronyms, such as, CAD - Computer Aided Design. To some companies, CAD stands for Computer Aided Drafting. Such differences can be overcome by the explanation of acronyms. The value of identifying business needs lies in the future strategic requirements of a business. There is little point in justifying an investment that increases capacity, when the strategic requirement of the business is to improve its quality. Likewise, investments that cannot be implemented, for example, due to manufacturing constraints, should be identified as soon as possible to prevent wasting valuable management time.

#### **7.1.7 Deficiencies 22 to 26.**

- 22. Failure to recognise effective use of capital.
- 23. Incapable of identifying future working capital/investments needs.
- 24. Ineffective where multiple cash outlays occur.
- 25. No time value of money.
- 26. Profits not referred to capital.

The main advantage of Cash Budgets is their use as a means to recognise the effective use of capital. None of the other methods addressed this deficiency. In identifying future capital, Cash Budgets again proved effective. However, Break

Even Graphical, Profit & Loss Accounts and Finjust also, addressed the deficiency. Over half the methods were ineffective where multiple cash outlays occurred. The time value of money was a deficit for Payback Period, Break Even Analysis, the objective methods and the Profit & Loss Account. Through the use of the Discounted Payback Period, the time value of money can be overcome for the Payback Period. Break Even Graphical, ROI, BCR, EAV, ROS, Asset Turnover and Finjust all referred profits to capital.

Few companies can afford to have capital not being utilised effectively. Under utilisation could ultimately influence the profitability of a business. By identifying future working capital/investment needs a business can ensure it will survive to reap the benefits of its new investment. Some investments require multiple cash outlays, such as, phased implementations or to avoid having capital tied up in non productive equipment. Through the use of the time value of money a more representative value for an investment can be formulated. Most traditional techniques employ the use of estimates for the rate of interest they could expect to obtain from other investments. Finjust and IVAN go further, by providing scenarios for pessimistic, expected and optimistic values. By referring the profits to the capital employed it is possible to gauge the success of an investment for the size of the company. For example, if a profit of £25,000 is made by a company, to identify whether this is good or bad, requires knowing the amount of capital that was employed to generate it. £25,000 may be a good sized profit for a small company, but not good enough for a multi-national.

#### **7.1.8 Deficiencies 27 to 30.**

27. Inapplicable for comparing investments.
28. Methods that are not based on sound accounting principles.
29. Reliance on subjective reasoning.
30. Unfamiliar methods for calculating sales revenue and cost factors.

Two methods, namely Cash Budgets and COQS are inappropriate for comparing investments. The probabilistic methods and the COQS were the only methods that are not accepted as sound accounting practices. Subjective reasoning was found amongst all non-accounting based methods. Due to the indecisive nature of overhead allocation involved in both Break Even Analysis and Break Even Graphical, subjectivity could be evident. The use of unfamiliar methods for calculating sales revenue and cost factors was only applicable to Finjust.

In justifying investments it is desirable to use a method that enables comparisons to be made amongst the various investments, to establish the 'best' option. Sound accounting practices are vital to ensure the acceptance of the cost justification results amongst a company's accountants. Subjective reasoning can distort the true value of an investment and as such, its use should be minimised. In developing a new method for cost justification, familiar techniques for calculating sales revenue and cost data should be employed. Failure to do so is likely to meet with disbelief in the viability of the results or deter use of the system.

#### **7.1.9 Deficiencies 31 to 34.**

- 31. Distortion of results when capital investment is large in the future.
- 32. Meaningless results when capital investment fluctuates frequently.
- 33. Meaningless results when cash flows are initially high then negative.
- 34. Refusal to invest due to large capital outlay.

IRR and ROI were cited in the literature survey as being unacceptable when capital investment was large in the future. The Profit & Loss Account was also included under this deficiency, as it is usually concerned with representing a twelve month period. Therefore, if the capital investment was not due for fourteen months, it would not appear on the first Profit & Loss Account, distorting the initial

results. In the case of frequent capital investment fluctuations only ROI suffered. IRR and ROI both were affected by high then negative cash flows. Refusal to invest due to large capital outlay was applicable only to NPV.

In justifying an investment it is important to be certain that the results are representative of the data entered. Distortion of the results can lead to acceptance of unsuitable investments or rejection of suitable investments. Care must, therefore, be taken in ensuring that distortions are avoided.

## **7.2 Analysis of the Deficiencies of Finjust**

From figure 21 Comparison of Current Cost Justification Methods, the Finjust method was found to possess the least number of deficiencies. All of these deficiencies, except for one, "the need to hold formal meetings to enter data and agree actions", were addressed by at least one other method. As a result, the other methods were analysed to identify which methods could be incorporated or adapted to overcome Finjust's deficiencies. Where this was not possible or applicable, alternative approaches were sought. Analysis began by identifying those methods that addressed the least number of Finjust's deficiencies.

All the methods, except Finjust, relied on the use of familiar sales revenue and cost data. As a result, deficiency 30 "use of unfamiliar data" was not a matter of adapting another method to fit in with Finjust, but, a case of identifying the financial and costing data currently used by businesses.

Deficiency 4, "fails to identify profitability of each product in a high variety environment", was only addressed by ROS. The Finjust method does employ ROS as a measure on a 'Company Wide basis', but by failing to consider the profit for each product group, it cannot calculate the individual product group

ROS. Alterations to the Profit and Loss Account as used by Finjust would be necessary.

Deficiency 22, "failure to recognise effective use of capital", was only addressed by Cash Budgets. The data used in Cash Budgets, although similar to that used in the Profit and Loss Account, is not concerned with identifying how much profit or loss a company might make. It is possible, that Cash Budgets will be used by the accounting and finance departments within a company, to help identify the amount of capital available for future investment. As such, there is a limited need to incorporate such a factor in a new cost justification method.

Break Even Analysis and Break Even Graphical were the only two methods that addressed the deficiencies, 2 "fails to calculate value of sales to recoup investment" and 3 "fails to calculate volume of sales to recoup investment". Therefore, either one or the other of the Break Even methods, would have to be included in an improved version of Finjust.

Deficiency 1 " fails to calculate time to recoup investment" is addressed by both Payback Period and Equivalent Maximum Investment Period (EMIP). Although Payback Period is cited as being one of the easiest methods to use and understand, it is synonymous with the application of hurdle rates. EMIP as a development of Payback Period, could also be used as a hurdle rate. Therefore, whichever method is used for identifying the time required to recoup the investment, it is likely to be used as a hurdle rate.

Deficiencies 6 "Overhead allocation that fails to specify precisely the difference between fixed and variable costs or manufacturing overheads and expenses". To address this deficiency requires improving the identification of overheads.

Deficiency 9, "use of estimated data", cannot be addressed in any method that requires the use of forecasts or projected data. The use of Sensitivity Analysis or Monte Carlo Simulation could reduce the risk.

Deficiency 16 "not the easiest to use and/or understand", although addressed by Payback Period, Break Even Analysis, IRR and ROI, cannot be addressed by just incorporating other methods. To improve the ease of use of Finjust, would require the development of detailed advice - either in the form of a manual or on screen 'help' - to guide the user through the methodology.

Deficiency 24 "ineffective where multiple cash outlays occur" relates to Finjust's inability to allow the user to enter multiple investments at different rates of interest and/or over differing time periods. Therefore, to address this deficiency requires improving the approach adopted by Finjust and not through the use of other methods that do not suffer this deficiency.

### **7.3 Deficiencies of Finjust's CBT**

From the critique of Finjust in Chapter Five, the deficiencies of the computer based tool include:

1. No time factors or explanations relating to completion of the justification - not even approximations. Finjust should be capable of being completed quickly, so that the potential benefits can be realised quickly.
2. Does not encourage commitment and ownership.
3. No advice to assist in collecting data and perform some actions. This includes: In the scenario analysis, no advice is available to assist the user in reaching agreement on the values to enter for the influences, other than the default settings.

4. Hidden calculations. The formulas used to calculate the effect the Inflation Rate and Base Rate have on the sub-factors of the Profit and Loss Account, are not displayed and as such, denies a company from entering its own, should it disagree with the formula.
5. Use of key manufacturing similarities to identify Product Groups, when much of the data required is related to Sales Products.
6. Over simplification of the factors of the Profit and Loss Account. Resulting in confusion over overhead allocation, calculation of the sales revenue and other cost factors.
7. No option to specify the business needs of a company. Business needs are automatically selected, based on input of financial data to specific cells.
8. Inability to specify scenarios for individual Product Groupings. No options exist for specifying individual changes to Product Groupings.
9. Inappropriate use of graphics that hide vital information.

#### **7.4 Summary**

In comparing the deficiencies of the cost justification techniques examined in Chapters 3, 4 and 5, not surprisingly the most recent, the Finjust methodology, was found to have the least number of deficiencies, eleven out of a possible thirty-four. Of the deficiencies identified, only one was exclusive to Finjust, "the use of difficult to quantify and inappropriate units to calculate sales revenue and cost factors".

Failure to calculate the volume of sales to recoup investment was common to all current techniques except the Break Even Analyses. Overhead allocation that fails to specify precisely the difference between fixed and variable costs or manufacturing overheads and expenses was not a deficiency of Cost Benefit Analysis, Return On Sales or the Cost of Quality Schedule. Not the easiest to

understand and/or use was applicable to all bar the Payback Period, Break Even Analysis, IRR and ROI. Reliance on estimated data was relevant to all approaches except Payback Period and the Profit and Loss Account. Ineffective where multiple cash outlays occur, applied to nearly half of the approaches.

Of the deficiencies identified from the comparison of cost justification techniques (figure 22), the following were found to be the most serious and would need to be addressed in any new cost justification methodology.

10. Use of 'Hurdle Rates'.

Encourages managers to seek short term contribution to profits at the expense of long term strategic issues.

11. Failure to advise on the 'Cost of Doing Nothing'.

Necessary to recognise the urgency involved in implementing new manufacturing investments and to identify a 'base line' by which to compare the effect of investments.

13. Failure to consider the effect an investment has on the company as a whole.

By addressing this deficiency, the impact an investment has on a company in terms of profitability is considered.

14. No advice on identifying intangible benefits and costs on a 'Company Wide' basis.

Failure to consider intangible benefits assigns them a value of zero. The benefits and costs of new investments should be identified on a 'Company Wide' basis and not just in the area of implementation to ensure the full impact is considered



21. No formal meetings to enter data and/or agree actions.

This is necessary to ensure the validity of the actions agreed, data entered and to encourage commitment and ownership of the Company personnel to the cost justification process.

24. Ineffective where multiple cash flows occur.

It is essential to consider the effect of multiple cash flows to fully comprehend the long term effect of new investment.

25. No time value of money.

The effect of inflation, price changes and other external influences, on both benefits and costs over time, should be considered in developing a new cost justification technique.

27. Inapplicable for comparing investments.

With the plethora of new investment opportunities, it is vital to be able to compare investments to ascertain the most suitable investment.

28. Methods that are not based on sound accounting principles.

To be valid and acceptable to company accountants a new cost justification technique must be based on sound accounting principles.

30. Unfamiliar methods for calculating sales revenue and cost factors.

To avoid rejection of any new technique, unfamiliar methods should be avoided.

31. Distortion of results when capital investment is large in the future.

Options should be available to consider investments for the long term, to allow for large capital investments in the future.

In the analysis of the Finjust computer based tool (CBT), nine deficiencies were identified from the critique undertaken in Chapter Five.

Six of Finjust's CBT's deficiencies were similar to deficiencies identified in the comparison of cost justification techniques. The three remaining were:

- No advice in collecting data.
- Hidden calculations.
- Over simplification of the Profit and Loss Account.

Finjust was not compared with the other cost justification approaches on the basis of the computer based tool (CBT), because none of the other approaches were available as CBT's.

## **Chapter 8.0 Specification for a New Cost Justification Methodology**

### **8.1 Introduction**

In developing the specification, for a new approach for the cost justification of investments in manufacturing, it was decided to create a representative name. The name had to be significantly different from "Finjust" and, preferably, reflect the method adopted, that is, the Profit and Loss Account, as well as, relating to businesses, the evaluation of manufacturing investments and the use of a workbook and computer based tool.

Subsequently the word PROFIT was selected. It stands for:

PROgram for Financing Investments in Technology.

For each of the most serious deficiencies identified in Chapter 7, Finjust addressed all except two. Therefore, to develop a new approach, possible practical solutions will be sought to address the two most serious deficiencies that apply to Finjust, as well as, the other deficiencies identified in Figure 22 - The Comparison of Cost Justification Techniques and the deficiencies of Finjust's CBT identified in Chapters 5 and 7.

### **8.2 Specification to Redress the Deficiencies of Finjust.**

Finjust recommends that a company's products should be grouped according to their key manufacturing similarities, however, because this is not common practice, companies could use other methods. In Stratagem [60] and from

consultations with manufacturing companies, such as, BAeCAM, products are generally classified as Sales Product Families based on:

- **Functionality** - A manufacturer of electric goods could form families based on functions i.e. Washing machines, freezers, refrigerators, etc.
- **Features** - Strength, flexibility, torque, etc.
- **Market Segment** - Basic models, standard models, executive or sophisticated models, etc.
- **Size** - A car manufacturer could group cars by their engine size, i.e. 1100 cc/1600 cc/2 litre, etc.
- **Material** - A wire manufacturer could group products based on common materials, i.e. Steel, copper, graphite, etc.

As a result, it was decided to adopt this method of classification. Also, it is considerably easier to collect sales volume, price and cost data on Product Families based on Sales rather than their manufacturing similarities.

Finjust makes no recommendations for the collection of the data for constructing the financial model, the scenario analysis or for the input of costs and benefits of the investments suggested. Neither does Finjust provide any assistance as to when or how the data should be input, where or how and by whom agreement is reached. To address these disadvantages, PROFIT would require some form of collection sheet, guidance notes, timetables and meetings. In Stratagem [60] Pro-formas are specifically designed to collect only the required data. To assist the user, Pro-formas accompanied by Toolkits are supplied, detailing the format in which the data is required. Workshops are held to discuss and reach agreement on the data collected. Through the use of Deliverables, specific tasks must be completed prior to the next Workshop, such as, data entry. Tool Kits are available to provide assistance during Workshops. By adapting the system used by Stratagem, PROFIT would redress the disadvantages found in Finjust.

Deficiency 30 "use of unfamiliar sales revenue and cost data", requires radically changing the data requirements and calculations used for building Finjust's Profit and Loss model.

Sales Revenue requires a company to input a value for the market volume for a product, their market share of that market volume and the unit price of the product sold. Finjust then calculates the volume of goods they have sold by multiplying the market volume by the Company's market share and then multiplies the answer by the unit price. It is unlikely many small and medium enterprises would be aware of the market volume of their product range. Even if they did, to calculate their percentage market share it would be necessary for them to divide their actual sales into the market volume.

Instead of calculating Product Sales Revenue the Finjust way, it would be preferable to use Volume Sold x Average Unit price. The Marketing or Sales department should be able to supply this data.

In the case of Service Sales Revenue = Training and Consultancy + Spares + Maintenance + After sales service + Two other unspecified options, it would be simpler to suggest that a company looks at these activities as Sales Product Families. For example; Training and Consultancy could be one Sales Product Family, Maintenance and After Sales Service another, etc. Such action would also remove the problem of apportioning a percentage of revenue amongst five or six Sales Product Families.

In collecting data on the cost factors of the Profit and Loss Account, an improved breakdown of the account and more detailed information could prove useful.

In the case of Material costs, Finjust uses volume of goods sold multiplied by the raw material costs, plus an allowance for raw material scrap and volume of goods

sold by the bought out part cost. The problem here is that the volume of goods sold might not be the same as the number manufactured using raw materials or the same as the volume assembled from the bought out parts. Also, the bought out parts could involve scrap, rework and damaged goods. A calculation that takes these factors into consideration should be used.

Finjust's over simplification of the Profit and Loss Account does not include a manufacturing or production overhead.

Although some companies may use the formula in Finjust to calculate Labour costs, other companies apply a dual production overhead and labour charge per hour, others use Activity Based Costing, Absorption or Marginal costing.

Therefore, to cover for such differences, it would be better to offer an option for the user to enter a value per Sales Product Family, to cover Direct Labour and Production Overheads. Where a company is undecided, an option could be provided that requests the input of a lump sum, to cover both Direct Labour and Production Overheads, and then the lump sum could be apportioned on an arbitrary basis, such as, Sales Revenue, to each Sales Product Family.

Inventory Costs in Finjust are calculated by the user entering a percentage value based on the total raw material costs. This fails to consider the bought out parts, work in progress (WIP) and the finished goods inventory. Therefore, PROFIT should request data on raw materials, bought out parts, WIP and Finished Goods.

The raw materials and bought out parts, would require entering the opening stock value, adding this to the purchases and then, subtracting the closing stock. Work In Progress (WIP) could be calculated by requesting the opening stock and closing stock of WIP, the difference would be the WIP value used.

Finished Goods Inventory requires requesting the opening stock, then calculating the difference between the goods produced and goods sold to identify the closing inventory. The cost of the Finished Goods Inventory will then be the closing stock volume multiplied by the sum of the raw material, bought out parts, WIP and Production Overheads.

To calculate the loss of income from monies tied up in Finished Goods inventory and the cost of maintaining the inventory in terms of people and buildings, will require entering a value under the general overheads, referred to as "Expenses" in PROFIT. The term "Expenses" is used to ensure a distinction exists between production overheads and company wide overheads.

In Finjust, Overhead Costs include all overheads, manufacturing, assembly, administration, marketing, management plus buildings, rent and rates, finances and others. Finjust does allow the user to change the titles for the overhead costs but not where they are in the simplified Profit and Loss Account. PROFIT, as stated earlier, differentiates between production overheads and 'Company Wide' overheads. Production overheads are entered under Cost of Sales, company wide overheads are entered under Expenses. Production overheads are apportioned to sales products, based on volume and unit price. Expenses are company wide and, therefore, appear as a lump sum, that is, not apportioned. By classifying overheads, PROFIT overcomes deficiency 6, "Overhead allocation that fails to specify precisely the difference between fixed and variable costs or manufacturing overheads and expenses".

Finance costs in Finjust are displayed separately, in PROFIT, they will be part of Expenses.

Deficiency 4, "fails to identify profitability of each product in a high variety environment", could be addressed by the use of ROS. However, this requires

expanding the Profit and Loss Account to calculate the profit for each Product Family. By including a Manufacturing or Production account into the Profit and Loss Account, data specific to each Sales Product Family can be readily viewed. The Production account represents the cost of producing the Finished Goods sold. Any unsold goods are added to the Finished Goods inventory. By subtracting the Cost of Sales from the Sales Revenue the Gross Profit for each Sales Product Family can be calculated. Similarly, the Gross Profit can be calculated on a Company Wide basis, by subtracting the Total Cost of Sales from the Total Sales Revenue. By dividing the Gross Profit by the Sales Revenue for each of the Sales Product Families and multiplying by 100, the Gross ROS for each Sales Product Family can be found. Likewise the Gross ROS on a Company Wide basis can be found by dividing the Total Gross Profit by the Total Sales Revenue.

Deficiency 22, "failure to recognise effective use of capital", was only addressed by Cash Budgets. Because Cash Budgets are not concerned with profit or loss, their incorporation into a Profit and Loss Account based cost justification model is not feasible.

Break Even Analysis and Break Even Graphical were the only two methods that addressed the deficiencies, 2 "fails to calculate value of sales to recoup investment" and 3 "fails to calculate volume of sales to recoup investment". In order to calculate the volume of sales required using either of the Break Even methods, demands that the cost factors in the Profit and Loss Account be separated into fixed and variable costs. To overcome the variance amongst companies as to which cost is fixed and which is variable, PROFIT will use Expenses to represent Fixed Costs and Cost of Sales to represent the Variable Costs. By providing an explanation of the components of the equation, the user can decide on the value of the answers calculated by PROFIT.



Deficiency 1 " fails to calculate time to recoup investment" is addressed by both Payback Period and Equivalent Maximum Investment Period (EMIP). However, using the formula:

$$\text{Payback Period (years)} = \text{Net Investment} / \text{Annual Cash Flows}$$

And substituting the Gross cash flow resulting directly from the investment for the Annual Cash Flows, the Payback Period can be calculated, as shown in figure 23.

Year	Investment Cost	Gross Cash Flow from Investment	years	months
0	-1420			
1	-670	750	1	0
2	-270	400	1	0
3	-70	200	1	0
4	30	100		8
5	80	50		
Payback Period (Years+Months) =			3	8

Figure 23 Payback Period using Gross Cash Flow.

Deficiency 9, "use of estimated data", cannot be addressed in any method that requires the use of forecasts or projected data. Through the use of projected versions of the Profit and Loss Account it is impossible to avoid the use of estimated data. Through the use of the Scenario Analysis option, Finjust does offer the user the opportunity to enter values for optimistic, expected and pessimistic future scenarios. However, the Finjust method, by applying the Future Influences to all Product Groupings, limits the effectiveness of this option. Also, the formulas used to calculate the effect the Inflation Rate and Base Rate have on the sub-factors of the Profit and Loss Account, are not displayed denying a company, should it disagree with the formula, from entering its own formula. Nor

is there any advice available to assist the user in reaching agreement on the values to enter for the influences, other than the default settings.

By increasing the Scenario Analysis to include varying values for each Sales Product's volume, unit price, percentage scrap of finished goods, work in progress, raw material costs, bought out part costs and production overheads and for the Company Wide expenses over, at least, the expected time period of the investment, a powerful analysis option could be provided. The provision of an information sheet to explain some of the main techniques in sales forecasting could also be advantageous.

Deficiency 16 "not the easiest to use and/or understand", although addressed by Payback Period, Break Even Analysis, IRR and ROI, cannot be addressed by incorporating any of these methods. To improve the ease of use of Finjust, would require the development of detailed advice - either in the form of a manual or on screen 'help' - to guide the user through the methodology. The development of a tutorial that explains each stage with examples could provide valuable assistance.

Deficiency 24 "ineffective where multiple cash outlays occur" relates to Finjust's inability to allow the user to enter multiple investments at different rates of interest and/or over differing time periods. To address this deficiency, requires improving the approach adopted by Finjust and not through the use of other methods that do not suffer this deficiency. Through the use of Pro-formas or Deliverables detailing when an investment is expected to start, its duration, payment frequency, value of payment and to which product it refers or whether it is a 'Company Wide' investment, would overcome this deficiency. The Pro-formas or Deliverables would require linking to the Profit and Loss Account over the required time period. Where a monthly investment started after the beginning of the year, for example three months in, then the figure that would appear under

Expenses in Finance Costs would have to allow for this, that is, there would be nine monthly payments.

### **8.3 Specification to Redress the Deficiencies of Finjust's CBT**

From the critique of Finjust in Chapter Five, there were nine deficiencies identified in the computer based tool. Of these, four have been redressed in the previous section. The five that remain to be addressed are:

1. No time factors or explanations relating to completion of the justification - not even approximations. Finjust should be capable of being completed quickly, so that the potential benefits can be realised quickly.
2. Does not encourage commitment and ownership.
4. Hidden calculations. The formulas used to calculate the effect the Inflation Rate and Base Rate have on the sub-factors of the Profit and Loss Account, are not displayed and as such, denies a company from entering its own should it disagree with the formula.
7. No option to specify the business needs of a company. Business needs are automatically selected, based on input of financial data to specific cells.
9. Inappropriate use of graphics that hide vital information.

Deficiency number 1, can be resolved by recommending a time period in which to conduct the evaluation.

Deficiency 2 can be redressed by providing Workshops where management can meet to discuss the stages of PROFIT, agree on actions and complete Deliverables. Through this structured analysis of a company, managers gain an understanding of the financial implications involved in justifying new investments.

Deficiency 4 can be resolved by explaining the content, context and scope of the equations, assumptions and calculations involved in the method. Where a company disagrees with the explanations, options could be provided to allow for alternative reasoning to be entered. However, the provision of such an option must be counter balanced against possible errors or inconsistencies in the user's method.

Deficiency 7 in Finjust assumes a company knows where it can achieve benefits in order to reach its target profit or ROT. From this input, Finjust automatically specifies a business need. But not all companies are aware of where potential financial changes could occur. Therefore, by allowing a company to experiment, with the sales revenue and cost factors of the Profit and Loss Account, for example, by increasing sales volume, reducing cost of sales or expenses, PROFIT could provide a company with a valuable training tool that assists managers in understanding the full impact such changes might have on the profitability of their company. The author, also, believes it would be beneficial to provide a company with a separate option to enable a company to identify appropriate business need(s), prior to undertaking an analysis of an investment. Such an option would help to ensure that full agreement amongst the management of a company existed and provide a common basis by which potential investments were investigated.

Deficiency 9 can be resolved by offering the user a selection of graphs to create, from the data entered or calculated.

#### **8.4 Additional Specifications**

From the research in Chapters Three, Four and Five, all the methods, except Finjust, were based on the assumption, that a company had an investment in mind to evaluate. Finjust differed, in that it recommended possible investments to resolve a company's business need(s) and then, when the company had selected an investment, evaluated it. Therefore, in order to build an improved financial evaluation method, an option should be available for those companies who have an investment to evaluate.

Another area of Finjust that, although acceptable in its current state, could be further refined is the display of the projected future scenarios. In its present form, Finjust displays the current financial status of a company - year 0, and on the user entering a time period in years for the future projection, for example 5 years, Finjust calculates and displays what the financial status will be in five years hence. Finjust does not show years one, two, three or four. By displaying the intervening years, a company could view the effects of multiple cash outlays (Deficiency 24), as well as, cash inputs. Also, a company would better be able to identify the financial implication involved in implementing their selected investment.

By providing both of these refinements, the first additional specification will increase the scope and application of the PROFIT Methodology and the second will increase the creditability and functionality by providing a clearer expression of the Profit and Loss Account over time.

## **8.5 Summary**

The specification of a new approach for the cost justification of investments in manufacturing tools, techniques and technologies which alleviates the deficiencies identified in Chapter 7 has been developed.

Whilst the new methodology builds upon some of the underlying principles contained in the Finjust methodology, it will significantly enhance the area of application, remove inconsistencies and uncertainties and improve user ownership and commitment to the cost justification process.

The new approach has been termed PROFIT - PROgram for Financing Investments in Technology.

The deficiencies of Finjust have been explored and where appropriate addressed.

Traditional cost justification approaches have been incorporated to address some of the deficiencies of Finjust, namely, Payback Period - to calculate the time required to recoup the investment, Break Even Analysis, to identify the volume and value of sales required to recoup the investment, and ROS - to identify the profitability of individual Sales Products/Sales Product Families.

In order to gain management commitment and ownership, the use of Workshops have been incorporated in the structure of the improved methodology.

Other deficiencies in respect of the ease of use of Finjust have been addressed by including in the PROFIT Methodology advice and assistance in the form of Toolkits, Pro-formas to aid the collection of data and Deliverables to ensure actions relating to Workshops have been agreed to.

In developing the specification for PROFIT, three options were identified as necessary:

1. Identify Business Need(s).
2. Identify possible Investments.
3. Evaluate an Investment.

A final observation is the value PROFIT can provide to companies in training management to use a structured, analytical approach for the financial evaluation of investments.

## **Chapter 9.0 Business Needs, Processes, Investments and Benefits.**

### **9.1 Introduction**

In an introduction to *Managing in the 90's - The Competitive Response* [61], The Rt. Hon Michael Heseltine MP claims:

"The business with the best prospects for long term success seem likely to be those which recognise the need for positive changes: to adapt, to innovate and to plan for continuous improvement and the introduction of best practice into all their activities. An essential prerequisite to achieving 'best practice' is to ensure that proposed improvements, in particular investments in manufacturing tools, techniques and technologies are applied to address real **Business Needs**. This is essential if scarce manufacturing resources are deployed to the greatest effect."

The term 'Business Need' as used here is defined as follows:

The required improvements in performance necessary to maintain its competitive advantage.

### **9.2 Specifying the Business Needs**

From the Profit and Loss account, for a company to increase its profits, there are three options. It can increase its sales revenue, reduce its costs or do both.



Therefore, increase sales revenue and reduce costs could both be considered primary Business Needs.

To increase sales revenue requires either increasing the product's unit price or increasing the volume sold. Where a company decides to increase the unit price to increase sales revenue, increasing the price alone, could cause a reduction in sales volume, thereby, cancelling out the expected increase in sales revenue. But, by offering the customer some form of improvement, the customer may be prepared to pay a higher price. Therefore, for a company intending to Increase Sales Revenue by increasing the price, the required improvements become the Business Needs.

For a company that is selling all it can make, to increase its sales revenue, without jeopardising its volume of sales through increased prices, it must have the capability to increase its output. Again, the Business Need, increase output, becomes the improvement.

Where a company is not selling all it can make, then it should identify why not. Its Business Need then becomes the improvements it must make in order to sell more.

To reduce costs requires making improvements in the methods used to produce the product and/or in the methods employed in selling it.

In order to identify possible improvements a company must look at how it can improve its competitive advantage. In *Competitive Manufacturing - A Practical Approach to the Development of a Manufacturing Strategy* [62], seven criteria have been identified that represent the needs a business should question, in order to improve its competitive advantage.

They are:

1. Price: Selling the product at the lowest price.
2. Delivery Lead Time: Delivering the product within the lead time required by the customer.
3. Delivery Reliability: Delivering the product to schedule.
4. Quality: Producing products that meet the required specification.
5. Design Flexibility: The ability to produce the product to the satisfaction and specification of the customer.
6. Product Features: Adding capability to products or increasing the choices offered to customers.
7. Volume Flexibility: The ability to produce the product to the satisfaction and specification of the customer without changing the lead time.

Through literature searches and discussions with Academics at the University of Plymouth, the seven criteria, specified above, were expanded and adapted to form the following Business Needs:

#### **9.2.1. Reduce Costs.**

In looking to reduce costs a company has identified that its Sales Products are being produced at too higher a price or that the Expenses for the whole company are too great. Sales product costs in a company relate to raw materials, bought out parts, work in progress, finished goods inventory, scrap rates, production overheads - including direct labour, energy consumption, depreciation of plant and equipment purchased for production. Company wide costs are covered by Expenses, such as, salaries, administration costs, selling costs, maintenance, cost of holding inventory, depreciation of buildings and plant, rates and rent. Expenses are those costs that are not covered by production overheads or directly related to sales product costs.

### **9.2.2. Reduce Lead Time.**

By reducing lead time, that is, the length of time it takes to manufacture a product, a company could expect to reduce its costs - quicker throughput results in greater turnover of stock. Reduced idle time and set-ups, reduce lead time by better use of machinery and plant. By reducing lead time a Company can improve its overall delivery performance, which can, where customers select products based on the time factor, result in savings from the purchase of increased quantities of raw material and bought out parts - economics of scale.

### **9.2.3. Improve Delivery Performance.**

Delivery performance relates to the time quoted from receiving an order from a customer to delivering the product to the customer's premises. Poor delivery performance forcing customers to wait, can result in lost orders. Even where a company competes well on quality and price, customers who require a product urgently might not be prepared or able to wait. Poor delivery performance also increases Work In Progress (WIP), reducing throughput of other products and ultimately profits.

### **9.2.4. Improve Product Quality.**

Improved quality can command a higher unit price for a product or service, thereby, increasing profits without increasing product costs. Improved product quality can also results in savings from reduced scrap and rework throughout the production of the product. Quality can be measured by savings derived from reduced scrap and rework, reduced test and inspection personnel, often resulting in reduced production costs, raw material costs, direct labour and production overheads. A quality product can also reduce after sales costs, through reduced warranty claims, insurance, recalls, etc.

In addition, by improving the quality of the design drawings, the risk of errors occurring on the shop floor, such as, incorrect reading of tolerances, can be avoided. Re-negotiating supplier contracts to ensure consistent quality overcomes the need to employ quality test personnel in goods in and avoiding delays due to shortages resulting from having to return goods or re-order additional supplies. Improved product quality can result in improved 'ownership' and commitment of employees to processes they control.

#### **9.2.5. Improve Customer Service.**

Improving customer service requires improving the quality of the services offered to a company's customers. Customer service relates to areas such as, after sales service, warranties and guarantees, customer complaints, enquiries, requests for brochures and price lists. Improving customer service can ensure customers remain loyal to the company and introduce other customers. This can have a knock on effect in reducing lead time, cost reduction and increased sales.

#### **9.2.6. Improve Functionality and Features.**

By offering the customer products that have improved functionality and features, a company could charge a higher unit price for its products or it could persuade a customer to buy the company's product instead of those of a competitor. Improving functionality and features also incorporates the removal of unnecessary functions or features which require complicated operating instructions, specialist maintenance agreements or unused features.

#### **9.2.7. Increase Capacity.**

Increased capacity provides a business with the capability to sell more products to meet demand and compete in fluctuating markets without incurring large stocks

of inventory. It can also, provide the opportunity to increase buffer stocks to allow production to stop while maintenance work is undertaken on plant and machinery, without jeopardising sales.

### 9.3 Identifying Business Needs

For a company to identify its Business Needs, requires questioning which improvements it must make in order to improve profitability over a specific time period.

The PROFIT Methodology can be used to assist a company in identifying possible Business Needs by relating changes made to the Profit and Loss Account to specific Business Needs. For example, by increasing the unit price of the products sold, the sales revenue generated will increase. But unless improvements are made to the products sold, it is likely that the sales volume will decrease, at best reducing the expected profit and at worst creating a loss. To avoid this occurring, improvements that add value to the products must be made. These improvements are the Business Needs, such as, reducing the lead time, improving the delivery performance, product quality, customer service, functionality and features.

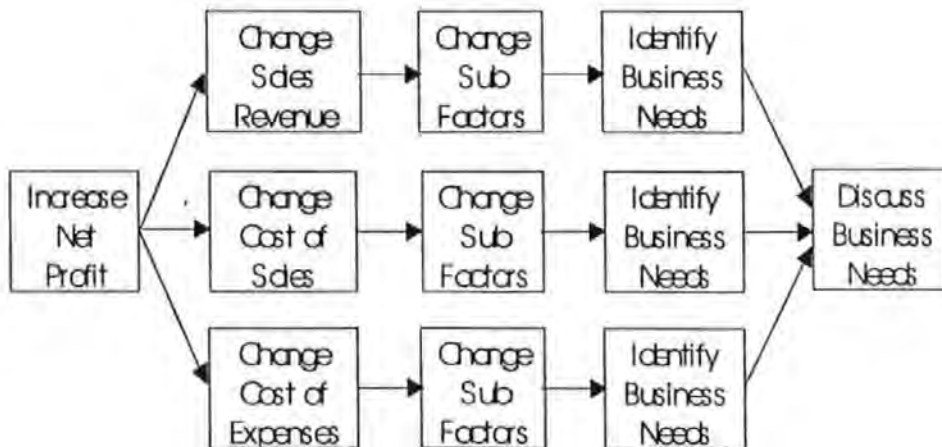


Figure 24 Overview of mechanisms used to identify Business Needs.

In Appendix I, figures 25 to 36 show the logic used to identify possible Business Needs derived from changes to the Production, Profit and Loss Account.

Inevitably, more than one Business Need could be identified as pertaining to the changes made in the Profit and Loss Account. In such circumstances, the company could carry out the analysis for all the Business Needs. But, this could be a very time consuming activity and, therefore, a means to limit unnecessary analyses needed to be established.

In the next stage of the PROFIT Methodology, the potential of the company to change its business processes is ascertained, for there is little point in identifying Improved Functions and Features as a Business Need, if the design of the product cannot be changed.

#### **9.4 Identifying the Potential for Change**

The potential for change refers to a company's ability to change its current business processes in order to invest in new technologies.

In identifying the potential for change within a manufacturing company, it is important to eliminate the need for departmental classification, because not all companies have the same departments, for example, some companies do not have a Personnel Department [63]. Also, not all companies use the same name for the same department, for example, when referring to materials management some companies use the term Inventory Department, while other use Stock Control. Even where companies do use the same name, the activities performed by the departments may vary.

To develop a methodology that allows for individual variance amongst companies when defining departments, becomes very complex. Part of the Computer Integrated Manufacturing Open Systems Architecture (CIM OSA) is its representation of a manufacturing business in terms of business processes. CIM OSA simplifies the many and varied departments and functional areas that occur within different companies, (whether or not they are in the same manufacturing sector) to three basic processes.

The structure of a manufacturing business can therefore be represented by [64]:

- Operations
- Support
- Management

Through the use of the CIM OSA differentiation and by questioning the capability of a company to change its processes in a structured way, the potential for change within a company can be identified. Recognising that only the 'Operation' activities add value directly, whereas, 'Management' and 'Support' activities only add value by improving the performance of 'Operation' activities. This reduces the number of investments which may need to be considered as applicable for the Business Need identified.

However, where a company decides that more than one Business Need could be applicable, the PROFIT Methodology is constructed to enable multiple Business Needs to be analysed.

#### **9.4.1 Operation Processes**

The processes involved in Operations, relate to the products or services produced by a company.

Operation processes include:

- Product Design
- Process Design
- Production
- Materials Management

Product Design. This process provides the greatest potential for improvements, for up to 80% of a products costs are decided at the conceptual design stage [65]. Material and component choices are made that affect cost, lead time, due date conformance, quality, functionality and features and volume.

Process Design. The responsibility of Process Design is to select the most appropriate means of manufacture and/or assembly of the product as dictated by Product Design. They can recommend changes in the specification, enabling the product to be produced within the capabilities of the company's machines and processes or alternatively they can recommend the use of brought-out parts and components.

Production. This process determines how the manufacturing and/or assembling is to be organised and what delivery dates can be promised. Production also ensures quality levels during production are maintained and, where a process or machine is running out of tolerance, that the faults are rectified as early as possible to avoid producing scrap and rework.

Materials Management. The responsibility for the purchase, at the best price possible for the appropriate quality and specification, of the materials, parts, components, tools and sundries necessary to meet production, their storage and inventory control lie with Materials Management. Other responsibilities include



maintaining records on the quality, price and delivery reliability of suppliers and making this information available to Production and Scheduling to enable them to calculate reasonable production schedules. Inventory control covers Goods In, Work In Progress and Finished Goods. Communication with Sales is vital to guarantee that Finished Goods are available for sale [66].

#### **9.4.2 Support Processes**

Included in Support are the following processes:

- Finance
- Personnel
- Facilities
- Information Services

Finance. Responsible for the preparation of the annual accounts, wages, administration of customer and supplier accounts, investments in new plant and equipment.

Personnel. Covers staff recruitment, training, appraisal, salary structures, welfare and records.

Facilities. Responsible for communicating with Sales, Materials Management and Despatch to ensure the product is available to sell, distribute to customer and after sales service [66].

Information Services. Information Services provides information on current, historical and future forecast data, enabling analysis of Product Family costs, sales, fluctuations in demand, quality problems, etc. The data from Information

Services facilitates short, medium and long term decision making within the company and provides data for customers, Government bodies and investors on an external basis.

### **9.4.3 Management Processes**

Processes involved include:

- Scheduling
- Business Planning.

Scheduling. This process is responsible for planning and control throughout the production process, the levels of performance being measured against set targets. Scheduling also covers machine breakdown, delays in receiving materials and components, tool shortages, staff shortages, etc.

Business Planning. The business plan will form the basis on which the company will operate. It will describe the goals the company wants to achieve over a specified time period, the methods and strategies to be employed in reaching those goals, the cost and benefits that will result from those goals.

### **9.5 Linking Investments to Business Processes**

Possible investments were identified based on the sub-headings of the business processes of the CIM OSA approach. The example investments specified are **not** an all inclusive list.

Example Investments identified as relating to the sub-headings of Operations include, for Product Design the following:

Primrose, et al, [10] Scholz-Reiter [67], Scheer [68], Weatherall [69], Greenwood [70] and Kief [71], Kochan and Cowan [72], Robinson [73] Computer Aided Design (CAD). Boothroyd (74) and Mital [75] Design For Assembly (DFA), Standardised Products, Standardised Material Sizes (Raw Materials Only) and Modular Design. Ranky [76] Design For Manufacture (DFM). Marlow [77] and Hewson [78] Desk Top Publishing System. AAT [79], Ranky [80], Kochan and Cowan [72] Parts Database. Hughes [81] Design For Test (DFT), Formal Agreement of Requirements, redesign packaging materials and methods.

Examples of Investments for Process Design:

Ranky [76], Walley [82], Bonetto [83], Greenwood [70], Kief [71], Chandra and Harmonosky [84], O'Grady [85], Owen [86], Ford [87], Kochan and Cowan [72] Warnecke and Vettin [88], Hutchinson and Holland [89] Flexible Manufacturing System. Teicholz and Orr [90], Kochan and Cowan [72] Group Technology, Computer Numerical Control (CNC) and Distributed Numerical Control (DNC). Kief [71] CNC and DNC. Daly et al, [91] DNC. Weatherall [70] and Zahran, et al., [92], Williams and Rogers [93], Smart [94] Group Technology. Greenwood [70], O'Grady [85], Owen [86] Computer Numerical Control (CNC). Cheng and Podolsky [95] Reduce Scrap. Greenwood [70] Statistical Process Control (SPC). Zahran, et al., [91], Williams and Rogers [93], O'Grady [85], Owen [86], Weston, et al., [96], Jones and Saleh [97], Duffie [98], Ford [87] Cell Manufacturing. Hughes [81] Change Process, Process Simplification, Turning/Machining Centres, Minimise Assembly and Production Set Up Times, Pre Set Tooling, Automatic Tool Change, Co-Ordinate Measuring Machines,

#### Examples for Production:

Teicholz and Orr [90], Redford and Lo [99], Scheer [68], Weatherall [69], Greenwood [70], Kief [71], O'Grady [85], Owen [86], Felstead [100], Orr [90], Scheer [68], Kochan and Cowan [72] Computer Aided Process Planning (CAPP) and Production Control Data System. Primrose, et al, [10], Scholz-Reiter [67], Teicholz and Orr [90], Kochan and Cowan [72], McDonald and Hastings [103] Computer Aided Design Computer Aided Manufacturing (CAD/CAM). Moss [104] Continuous Improvement Monitoring and Condition Based Monitoring, Smith [105] Automatic Test Equipment (ATE). Ranky [76], Greenwood [70], O'Grady [85], Owen [86], Felstead [100], Kochan and Cowan [72] Automated Guided Vehicles (AGV's). O'Grady [106] Optimised Production Technology (OPT)., Hughes [80] Yoki Poki. White [107] Preventative Maintenance. Boothroyd (74) and Miles [108] Flexible Assembly System. Hughes [81] Auto Insertion, Dedicated Assembly Machines, Accurate Shop Floor Production Data Collection, Accurate Capacity Data, Accurate Delivery Time Data.

#### Examples for Materials Management:

Teicholz and Orr [90], Kochan and Cowan [72] Inventory Management. Cheng and Podolsky [95], Kochan and Cowan [72] Kanban and Just In Time (JIT). Boulian, et al. [109] Just In Time. Scheer [68] Kanban and Automated Warehousing, Storage and Retrieval System. Greenwood [70] Just In Time (JIT) and Automated Storage and Retrieval System. Kochan and Cowan [72] Automated Storage and Retrieval System. Hughes [81] Automatic Packaging, Re-negotiate Delivery Contracts and Vendor Rating Management. Teicholz and Orr [90], Greenwood [70], O'Grady [85], Owen [86], Kochan and Cowan [72] Materials Requirements Planning (MRP).

For the sub-headings of Support, examples of possible investments for Finance:

Walley [82] Computer Supported Estimating and Costing. Rose (31)  
Activity Based Costing (ABC).

Examples for Personnel:

Teicholz and Orr [90] and Cheng and Podolsky [95] Quality Circles (QC).  
Greenwood [70], Boulian, et al., [109] Job Enrichment - Operator  
Responsibility. Kochan and Cowan [72] Corrective Action Teams (CAT).  
Hughes [81] Operator Training for Multi-tasking/skill, Operator Training,  
Operator Inspection Scheme, Training, On-Site Support Training, Hotline  
Support Training, Installation and Commissioning Training.

Examples for Facilities:

Moss [104] Warranty and Guarantee, Hughes [81] Vendor Rating  
Management, Open Orders, Procurement Engineering (Parts Only) and  
BS5750/ISO 9000. Electronic Data Interchange (EDI).

Examples for Information Services:

Hughes [81] Sales Order Processing System and EDI.

For the sub-headings of Management, examples of possible investments for  
Planning and Scheduling include:

Huckett [49], Broh [109], Greenwood [70], Boulian, et al. [109] Total  
Quality Management (TQM). Niebel [111] Energy Management, Moss

[104] and Smith [105] Pre-Planned Maintenance. Hughes [81] Factory Management Systems, Factory Scheduling Systems, Production Control System, On-Line Access to Operations, Management Information System, Business Process Simplification. Weatherall [69] Minimise Factory Layout. Sheer [68] and Childe [112] Computer Aided Production Management (CAPM). Sheer [68], Duffie [98], Kay [113], Kochan and Cowan [72], Warnecke and Vettin [88] Trial Kitting - Simulation and Sheer [68] Manufacturing Resource Planning (MRPII).

## **9.6 Linking Investments to Business Needs**

Whilst it is clear that many investments can be used to satisfy one or more different Business Needs, the Investments for each business process were linked to the Business Needs that they could address. Although this results in some duplication, it is intended to hone management's awareness to the importance of identifying suitable investments that are most likely to address the required Business Needs for the businesses processes that are capable of changing. For example:

If the Business Need were to Reduce Costs, one possible investment could be Computer Aided Design (CAD). Likewise, if the Business Need were to Improve Functions and Features, then CAD could also be a possible investment. The need to Reduce Costs will concentrate on possible savings, elimination of time consuming activities, increases in productivity, reductions in waste and rework, etc. Whereas, Improving Functions and Features would require changes necessary to improve the products developed by access to an on screen three dimensional design capability, improved drawings, elimination of 'stock outs'. However, duplication could occur because by Improving the Functions and Features it could also be possible to reduce scrap and rework.

### **9.7 Sales Products and Company Wide Analysis**

In the PROFIT Methodology, the analysis of an investment, or the identification of an investment, can be undertaken on both a Sales Product (Family) basis and on a Company Wide basis.

Investments that relate to Sales Products are not necessarily the same as those that occur on a Company Wide basis. For example;

- Modular Design relates to Sales Products and not on a Company Wide basis.
- A Management Information System relates to control on a Company Wide basis and not to a specific Sales Product.
- Electronic Data Interchange (EDI) can be used throughout a company in connection with individual Sales Products and between all Operations, Support and Management processes, on a Company Wide basis.

### **9.8 Development of the Rule Based Logic**

The development of the rule based logic questions are dependent on whether the analysis is to determine possible investments or to evaluate potential investments.

In the first instance, by identifying the Business Need and then using the CIM OSA concept of business processes, refinement of potential investments is possible. To achieve this demanded the building of a simple yes/no

questionnaire. Thereby, ensuring that the full implication associated with particular investments, vital for successful implementation, were considered.

For example, if the Business Need had been identified as Reduce Lead Time and the Potential for Change question was, "Can the Product Design Process be changed?" Then, if the answer were "Yes", Computer Aided Design (CAD), Design For Assembly (DFA), Design For Manufacture (DFM) and Parts Database, could all be possible investments. However, if the answer were to be "No", there would be little point in recommending any investments. The questionnaire would then continue to the next CIMOSA business process, in this example, "Can the Product Process be changed?". The questionnaire continues until all the possible Potential for Change questions have been answered.

In figure 37, Appendix I, examples of possible Investments can be identified by completing the Business Needs and the Potential for Change questionnaire (on a Sales Product and/or a Company Wide basis).

In the second instance the evaluation of an investment utilises the same principles as the first, but in a different order. An investment must be selected from the list of investments covered by the PROFIT Methodology. Then questions are asked to ensure that the company can change the necessary business processes. Where this is possible, the Business Need that the investment under analysis addresses must be determined. Where it is not possible to change the business processes, the company must return and select another investment or abandon the evaluation.

### **9. 8 Identifying the Benefits of Investments**

The Business Needs identified earlier could be classified as the benefits of certain investments. For example, the Business Need - Reduce Costs is quoted



by Cheng and Podolsky [95] as a benefit of JIT. The Business Need - Improve Quality, is suggested by Hockett [49] as a benefit of TQM. However, these benefits were considered too general in their application, and therefore, greater refinement of the definitions were sought. Primrose, Creamer and Leonard [10], identified on a Company Wide basis, twenty-five benefits of CAD and a further four for CAD/CAM links. The list of benefits is refined to provide as comprehensive a list as possible and yet avoid duplication. For example, the benefit 'reduce drawing office labour' is broken down into the benefits, 'reduction in number of existing draughtsmen' and 'avoid recruiting extra draughtsmen'. Although they display some similarities in content, they are different in that in the first benefit - redundancy costs could be included, while in the latter redundancy costs are not applicable and recruitment costs could be avoided.

The Primrose, Creamer and Leonard method of identifying the benefits of investments was adopted as the basis to be used by the PROFIT Methodology. However, the PROFIT Methodology differs, in that it requires the user to specify a Business Need, identify the Potential for Change of the business processes and then select an Investment. As a result, benefits were identified in relation to all three criteria - the Business Needs they fulfilled, the business processes that could change and specific technologies. For example, for the Business Need Improve Quality, the Investment TQM and the business process Change Sales Product Process Design, the benefits, instead of just being improved quality, became improved process control, improved 'ownership' of operations, reduced absenteeism, reduced scrap and rework, reduced machine breakdown, reduced time spent testing, reduced engineering design changes and reduced recalls.

From the research on identifying investments, benefits were often also quoted. These formed the list of benefits that were developed for the PROFIT Methodology.

## **9.9 Summary**

Seven Business Needs have been identified as relevant to assisting companies in evaluating new investment. Business Needs have been defined as the required improvements in performance necessary to maintain a company's competitive advantage.

The seven Business Needs are:

- Reduce Costs.
- Reduce Lead Time.
- Improve Distribution Performance.
- Improve Product Quality.
- Improve Customer Service.
- Improve Functionality and Features.
- Increase Capacity.

The PROFIT Methodology assists companies in identifying possible Business Needs through the use of the Production, Profit and Loss Account. Dependent on the changes that are made by rotating the sales revenue and cost factors of the Production, Profit and Loss Account, a company is directed, via the Identify Business Needs Mechanisms (figures 25 to 36), to possible Business Needs. Inevitably, one or more Business Needs will be identified, to assist a company the PROFIT Methodology questions a company on its ability to change its business processes.

The criteria for analysing the capability of a manufacturing company to change its business processes has been developed by adopting part of the CIM OSA differentiation. This has enabled the representation of a manufacturing company

to be based on its three main processes rather than on a department or functional area basis.

The three processes are:

- Operations
- Support
- Management.

By this action a set of rules were developed that questioned a manufacturing company on its potential for change. As many of the eighty-seven technologies, considered in the PROFIT Methodology, were biased towards Operations, this process was further refined into the four following sub-headings:

- Design
- Processes
- Production
- Materials Management.

From the Investments selected for use in the PROFIT Methodology, the benefits, both tangible and intangible, relating to each Investment, Business Need and Potential for Change, on a Company Wide basis, were identified.

From the research in Chapter 9, Business Need(s) to Investment links have been identified. Investments have been assessed as to their suitability based on a company's potential to change its business processes.

The Company Wide tangible and intangible benefits have been assigned to the Investments dependent on each Business Need and the capability of the Company to change its business processes as identified in the Potential for

Change. This has provided the information necessary to build a rule based logic system to question the user regarding the three possible options of the PROFIT Methodology:

- Identify Business Need(s).
- Identify Investment.
- Evaluate Investment.

## **Chapter 10.0 The PROFIT Methodology.**

### **10.1 Introduction.**

This Chapter presents the PROFIT Methodology, firstly, in outline with a description of the components of the process and, secondly, by describing the main procedures and tasks to be undertaken at each stage with the conditions that must be met before progression to the next stage. The full details of the methodology are described in Appendix IV, Volume 2.

The Chapter concludes with a synopsis of two examples of the methodology as used in evaluating a discrete investment and a coherent programme of investments in two SME's. Full details of the tests are provided in Appendix III, of this volume.

### **10.2 Components of the PROFIT Methodology**

The components of the PROFIT Methodology are:

- Pro-formas
- Deliverables
- Toolkits
- Workshops

Pro-formas are used in the collection of data. They specify the type of data required, the suggested source of that data and the format of the data. Pro-formas are numbered in relation to the Deliverables that they are to be used with.

For example, Pro-forma 13, although sent out with Deliverable 10 is used to complete Deliverable 13.

Deliverables represent data that has been discussed and agreed to by the Steering Committee. The data entered on Deliverables can either be that gathered via Pro-formas or the data agreed to in Workshops.

Toolkits provide the users of the PROFIT Methodology with notes for guidance on completion of Pro-formas and Deliverables. Toolkits also explain practices employed during Workshops, such as, identifying possible investments from a set of rules, as well as, listing the rules and brief descriptions that apply to some of all of the plethora of investments currently available.

As many of the solutions involved in the evaluation of new investment can be non-algorithmic Workshops are used. Workshops are the means adopted within the PROFIT Methodology to generate ideas, discuss those ideas and the data collected on Pro-formas within an egoless environment, where all contributions are valued. Workshops are necessary if agreement via consensus is to be reached. Through such actions Workshops encourage commitment and ownership to the methodology from user companies.

### **10.3 PROFIT Overview.**

The PROFIT methodology employs four main stages, (as shown in figure 38).

1. Launch
2. Financial Modelling
3. Evaluation Options.
4. Financial Justification.

**The first stage** involves the launch of the methodology to the prospective users of the Workbook and/or CBT tool. Followed by the identification of the sales products or sales product families that are to form the basis of the audit.

**The second stage** involves the financial modelling of the Company under its current operating structure, using a profit and loss account format displaying the net profit or loss and the Return On Sales (ROS). This stage also includes providing a value for the Future Financial Scenarios Analysis for the Company to show the effect if it continued as it is currently, without new investment.

**The third stage** offers the Company three options:

- **Option One** assists the Company in identifying its business needs. Progression to Option Two is automatic.
- **Option Two** is selected where the Company already knows its business needs and its potential for change, but is unaware of the investments available to address its business needs.
- **Option Three** is for the Company who has one or more proposals to evaluate and knows its potential for change and its business need.

**The fourth stage** is the financial justification of the investments, through the quantification of the 'Company Wide' benefits and costs. The decision to accept or reject a proposal can then be made by considering the effect the proposal could have on the Profit and Loss Account and Return on Sales (ROS), or the users can return to the third stage of the methodology to consider another option before reaching a decision on the proposal.

## **10.4 Stage One - Launch**

Stage One - Launch is shown diagrammatically in figure 39.

### **10.4.1 PROFIT Brief.**

Prior to the PROFIT Brief, the chief decision makers within the Company appoint the Finance Director to act as the controller of the PROFIT Methodology.

The Finance Director then appoints a PROFIT Manager to ensure the efficient and smooth running of the PROFIT Methodology and to be responsible for the data input. This is advisable as the data that will be required by the PROFIT Methodology could be financially sensitive.

The next task is to select the members of the Steering Committee who are to attend the PROFIT Brief. The Steering Committee should include Senior Managers from all the functional areas within the Company, although not all of the selected Steering Committee will be required to attend every Workshop. To ensure the full co-operation and ultimate success of the Methodology, the commitment of Senior Management cannot be over stressed. The members are told to bring with them, to the PROFIT Brief, their diaries to aid the time tabling of future PROFIT Workshops. Also at this point, Pro-forma 1 (PF1) is sent to the Marketing/Sales Director to enable the collection of data on the Company's Sales Product range to be prepared ready for the presentation in Workshop 1.

At the PROFIT Brief the Finance Director and the PROFIT Manager explain the PROFIT Methodology and assign the appropriate roles to the selected Steering Committee members, Deliverable 1 (D1).



The Brief ends when the time tabling of the future PROFIT Workshops has been agreed, Deliverable 2 (D2).

### **10.4.2 Workshop 1**

Workshop 1 begins as time tabled on Deliverable 2.

The analysis using PROFIT then begins with a presentation to the Steering Committee, by the Marketing and Sales Director of the Company's sales product range. Where the sales product range of a company exceeds six, the Marketing and/or Sales Director must divide the product range into Sales Product Families. The term 'Sales Products' will be used throughout the methodology but can be read as Sales Product Families, where applicable. Toolkit 1 provides advice on Sales Product Families. When agreement has been reached on the Sales Products to be used in the audit, Deliverable 3 (D3) is completed. Pro-formas 4a, 4b, 4c and 5a, 5b, 5c can then be sent out to collect the Sales Product data necessary for Workshop 2.

## **10.5 Stage Two - Financial Modelling**

Stage Two - Financial Modelling is shown diagrammatically in figure 40.

### **10.5.1 Workshop 2**

Before Workshop 2 can begin the PROFIT Manager must assure that Deliverable 4 and 5 have been completed from the data collected on Pro-formas 4a, 4b, 4c, 5a, 5b and 5c. Toolkit 2.1 describes how each of the revenue and cost factors for the sales products are broken down into their constituent parts, as represented in

the Profit and Loss Account and that this is necessary to enable changes later on in the PROFIT Methodology to occur.

An example of later changes, necessitating the break down could be:

If one of the benefits of a new proposal was to increase Product Family sales revenue by say 10%, then PROFIT, to provide a realistic representation of the true value of such a benefit, needs to be able to distinguish between increased sales revenue resulting from increased volume, and increased sales revenue resulting from an increase in unit price. Increased volume would mean increases in the cost factors - the raw materials, the bought out parts, the production overhead content - reducing the value of the benefit, but if it were just an increase in unit price then these cost factors would not change - maximising the value of the benefit.

The second step of Workshop 2 is to consider Deliverable 5 (D5) the Future Financial Scenario Analysis data.

Toolkit 2.2 explains the need to understand what would happen to the Company's profitability if it continued as it was, that is, the Cost of Doing Nothing (CDN).

The Cost of Doing Nothing (CDN), involves specifying, for a time period of 12 months, the values for Sales Revenue factors and the Cost factors. To provide a more realistic view PROFIT requests values for the Optimistic, Expected and Pessimistic Scenarios. The Steering Committee then discuss the values and when agreement has been reached, Deliverable 6 is completed.

The third step of Workshop 2 requires the Steering Committee to view the effect that the Future Financial Scenarios have on the Profit and Loss account and the Return on Sales, for the three scenarios. The Company can then gain an insight

into the urgency involved in implementing new Investment to maintain or increase profitability.

### **10.6 Stage Three - Evaluation Options**

Stage Three - Evaluation Options are shown diagrammatically in figures 41 to 43.

#### **10.6.1 Workshop 3.1 - Identify Business Needs**

The first step of Workshop 3.1 begins by rotating the Sales Revenue, Cost of Sales and Expenses factors of the Profit and Loss Account. In order to identify possible Business Needs and hone the investment to the most profitable, PROFIT requires the user to experiment with these values.

For example: What would be the effect if Sales Revenue were to increase by maximising the volume produced of Sales Product A? What effect would this have on the Company Wide Net Profit and ROS?

When the Steering Committee are confident they have exhausted all possible scenarios, they must then discuss, with the help of Toolkit 3.1, a Business Need which meets their requirements. When they have reached agreement they complete Deliverable 7 - (D7) Agreed Business Needs.

#### **10.6.2 Workshop 3.2 - Identify Proposal**

The first step of Workshop 3.2 begins by selecting a Business Need from the list provided in the PROFIT Methodology. Advice is provided, through Toolkit 3.1, to assist the Steering Committee reach a decision.

Business Needs fall into the following:

1. Reduce Costs.
2. Reduce Lead Time.
3. Improve Delivery Performance
4. Improve Product Quality.
5. Improve Customer Service.
6. Improve Functionality and Features.
7. Increase Capacity

Increased Sales Revenue could be considered a Business Need. But to increase the unit price without offering the customer an improvement in quality, lead time, delivery performance, customer service or functionality and features, it is likely that increased prices will be reflected in decreased sales volume, thereby, cancelling out the expected increase in Sales Revenue. To increase volume is largely dependent on the current capacity constraints of the company, therefore, for a company intending to increase Sales Revenue by increasing volume, their Business Need would be to Increase Capacity. For these reasons the PROFIT Methodology restricts consideration of Business Needs to those specified above.

Once agreement has been reached, Deliverable 7 - (D7) can be completed.

Step two involves identifying the potential for change within the Company. The potential for change questions identify which areas within a company can be changed and, therefore, reduce the number of possible investments that can be used to improve the profitability of the Company. Toolkit 3.2.1 provides assistance. For example:

If the potential for change question was, "Can the Product Design Process be changed?" If the answer were "Yes", then Computer Aided Design

(CAD) could be a possibility. However, if the answer were to be "No", there would be little point in recommending CAD.

Having answered the potential for change questions and completing Deliverable 8 - (D8) Agreed Change Potential, the Steering Committee is now ready to progress to the third step and select an investment suggested by the PROFIT Methodology.

Toolkit 3.2.2 provides help and assistance in selecting possible alternatives and a short description of the investments in PROFIT. Having made a selection,

Toolkit 3.2.3 explains the importance of developing and then challenging the investments suggested.

When the Steering Committee have reached consensus on the Investment(s) to analyse they proceed to Toolkit 3.2.4 - List of Benefits and complete Deliverable 10 - (D10) List of Benefits for Investments. Pro-forma 13 and Deliverable 10 are sent out to those people who could be affected by the benefits. Pro-forma 14 and Deliverable 11 - Cost of Investments are also sent out to those who might be affected, as well as, vendors, consultants, suppliers of hardware, software and/or machinery suppliers.

### **10.6.3 Workshop 3.3 - Evaluate an Investment**

The first step of Workshop 3.3 begins by the Steering Committee selecting one Investment from PROFIT's list. Having made a selection, Toolkit 3.3.1 provides assistance and explains the importance of developing and challenging the investments. When the Steering Committee have reached consensus on the investment(s) to analyse they can complete Deliverable 9 (D9).

Toolkit 3.3.1 is available to provide assistance.

The second step is to check that the potential for change questions do not clash with the requirements for implementing the selected Investment. If this should be the case, the Steering Committee can return to the first step and select another Investment. Alternatively the same Investment can be selected but this time further consideration should be given to the change potential questions. Toolkit 3.3.2 provides comprehensive advice.

Step three requires selecting the Business Need that best represents that required by the business. Toolkit 3.3.3 provides assistance.

Business Needs fall into the following:

1. Reduce Costs.
2. Reduce Lead Time.
3. Improve Delivery Performance
4. Improve Product Quality.
5. Improve Customer Service.
6. Improve Functionality and Features.
7. Increase Capacity

Having agreed the Business Needs, Toolkit 3.2.4 - List of Benefits can be used to complete Deliverable 10 - (D10) List of Benefits for Investments. Pro-forma 13 and Deliverable 10 are sent out to those people who could be affected by the benefits. Pro-forma 14 and Deliverable 11 - Cost of Investments are also sent out to those who might be affected, as well as, vendors, consultants, suppliers of hardware, software and/or machinery suppliers.

## **10.7 Stage Four - Financial Justification**

Figure 44 provides a diagrammatic representation of Stage Four.

### **10.7.1 Workshop 4**

Before Workshop 4 can begin the PROFIT Manager must insure that Deliverable 10 (D10) and Deliverable 11 (D11) have been completed.

Workshop 4 then begins with the Steering Committee discussing and calculating the values for the benefits, both tangible and intangible, associated with the selected Investment. Toolkit 4 provides comprehensive advice and examples to assist the Steering Committee place a quantifiable value on the benefits.

Deliverable 11 (D11) is then used to calculate the costs, investment period and interest rates involved with the Investment.

When the Steering Committee are confident they have quantified all the costs Deliverable 13 - (D13) should be completed, (these figures can be different for each selection made) and when they have agreed on the benefits Deliverable 14 (D14) should be completed.

### **10.7.2 Workshop 5.**

The data for the agreed quantified benefits are entered into the Profit and Loss Account. To calculate the effect on the Company's Profit of the proposal, the value of the benefits are input as **increases** in the Sales Revenue and **decreases** in the Cost factors of PROFIT's Profit & Loss account as appropriate.

The data for the agreed quantified costs are then entered into the Profit and Loss Account. The costs are input as **increases** to the Cost Factors of the Profit and Loss Account and/or as a **finance cost** to be depreciated over the relevant time period. Next the Investment Period and Interest Rate are entered to calculate the time period, frequency of payment and yearly cost of the investment. Toolkit 5 is available to provide assistance.

When the Steering Committee have agreed the profit or loss and the return on sales, resulting from the proposal, Deliverable 15 (D15) is completed for each of the years that the analysis covers.

The final step in the PROFIT Methodology involves the reaching of a decision regarding the financial justification of the proposed Investment. The Steering Committee view Deliverables 16 (D16) - the Future Profit and Loss Accounts with and without the proposed investment for the three scenarios of Pessimistic, Expected and Optimistic, for the short, medium and long term (as specified by the Company). By making comparisons of the future financial status of the Company, they are able to assess the viability of the proposal in purely monetary terms, that is, the effect the proposal could have if it were successfully implemented on the profitability of the Company as a whole or the price that could be paid by the Company if it did not make the Investment, that is, it continued to operate as is (the Cost of Doing Nothing).

At this point the Steering Committee can access Traditional Cost Justification approaches, Deliverable 17 (D17), such as, Return on Investment (ROI), Payback Period, Break Even Analysis, etc., thereby, highlighting the risks involved in using these out-dated approaches to the cost justification of new investments.



Finally, Deliverable 18 (D18) is completed by the Steering Committee. Having decided on whether to accept or reject a proposal, they can return to an earlier stage to carry out further analysis of other proposals or terminate the Methodology.

### **10.8 Validation of the PROFIT Methodology**

The main aims of validating the methodology were to ensure that the data required by the model was available, that the model was capable of performing the necessary calculations and that it could be understood by the users.

In ensuring that the model was suitable for use by SME's, the methodology was tested throughout its development with four SME's: first against case studies using historical data, enabling comparisons to be drawn between the actual outcome and that suggested by the PROFIT Methodology and secondly, through discussion with SME's who had undertaken the cost justification of new manufacturing investment. Feedback from both these processes was used to modify the methodology where necessary. For example:

- In the case of ensuring the data was available, changes were made to enable the input of either individual material costs or for the PROFIT methodology to apportion a lump sum based on a percentage value derived by dividing sales of an individual sales product by the total sales for all products.
- Other modifications, relating to performing calculations to encourage the methodology's use, required inclusion of some traditional methods, namely, Break Even Analysis, Payback Period, ROI, NPV and IRR.
- To validate the ease of use of the methodology required SME's undertaking a full cost justification exercise. This was achieved by testing the methodology in detail with two SME's. One company had a discrete

investment, the other a coherent programme to analyse. The financial analysis for both companies is explained in full in Appendix III.

### **10.8.1 Company A**

Company A is a small company manufacturing fluid dispensers and employs sixty-five people.

The Company knew that it needed to increase its capacity in order to improve its profitability. Therefore, it used the second option of the PROFIT Methodology, namely, identify an investment.

The Company considered two possible investments, one for an additional manufacturing machine, the other for a Flexible Manufacturing System. During Workshop 3.2 the Company decided that the second option would increase duplication of manufacturing processes far in excess of the business requirements in the foreseeable future and the analysis subsequently concentrated on the financial justification of the additional manufacturing machine.

The financial justification revealed that the additional manufacturing machine would significantly improve profitability, each year over the three years on which the analysis was based. Although the Payback Period, the method traditionally adopted by the Company, would also have justified the purchase because the Payback was within the three years stipulated by Company policy, the full implications and value of the investment could not have been fully appreciated, in the Company's view, by the Payback approach.

Company A found the PROFIT process to be practical, functional and thorough in its approach of guiding the Company through the identification of possible

investments, analysis of investment tracks and the financial evaluation of the selected investment.

### **10.8.2 Company B**

Company B manufactures scientific instruments and employs a staff of twenty-seven.

Company B believed that profitability could be increased by a combination of cost reduction and improved customer service. Discussions with the Company about its products, markets and marketing strategy revealed that:

- Customers usually have a fixed amount to spend.
- The products are built from modules which are configured to customer requirements.
- Orders are secured by meeting customer specification or by offering more modules (better value for money).

In effect this means that the Company's products are sold on price, as the reduction of costs allows the customer to obtain more for their planned spend.

The Company identified initially from the PROFIT Methodology, one possible investment, suggesting Re-negotiating Supplier Contracts. After undertaking the Identify Investment Tracks and Challenge Investment Tracks the Company decided to consider another investment - Training of its Delivery Personnel. The two investments were justified as a coherent programme, with their impact being analysed together on the two sales product families affected.

This analysis was undertaken successfully and the results obtained are shown in Appendix III. Company B found the PROFIT methodology easy to apply and

informative. The data collection method, via the Pro-formas, enabled the necessary data to be efficiently processed. The guidance provided by the Toolkits ensured the calculation of the components of the Production, Profit and Loss Account to be accurately determined. The flexibility of the process allowed reiterations of the 'what if' scenarios to be fully appreciated.

## **10.9 Summary**

In this Chapter the four main stages of the PROFIT methodology were specified and an outline description given for the testing of the methodology in two test SME's. The four main stages of the PROFIT Methodology comprise:

1. Launch. This stage involves the launch of the methodology to the prospective users of the Workbook and/or CBT tool. Followed by the identification of the sales products or sales product families that are to form the basis of the audit.
2. Financial Modelling, which involves the building of a modelling of the Company under its current financial operating structure, using a profit and loss account. This format displays the net profit or loss and the Return On Sales (ROS). This stage also, provides a value for the Future Financial Scenarios Analysis for the Company, to show the effect if it continued as it is currently, without new investment.
3. Evaluation Options, offers the Company three options:
  - Identifying business needs.
  - Identify possible Investments, business need known.
  - Evaluate possible Investments.
4. Financial Justification, through the quantification of the 'Company Wide' benefits and costs, the decision to accept or reject a proposal can then be made

by considering the effect the proposal could have on the Profit and Loss Account and Return on Sales (ROS). Alternatively the users can return to the third stage of the methodology to consider another option before reaching a decision on the proposal.

The ultimate test of the methodology was to apply it in a company considering making an investment to improve its business. Two such companies were identified and testing was undertaken successfully. Whilst this enabled the functionality of the methodology and its ease of application to be tested it could not assess its full potential in identifying appropriate and resilient investments. This assessment can only be determined over time.

However, the evaluation of the methodology provided the opportunity to test the capability and method of the process under two different circumstances. The first, in a company which applied stage three - option two of the methodology to identify possible investments, followed by the financial evaluation of a discrete investment. In the second company stage three - option one was chosen. This required the identification of the Company's Business Need(s) before identification of one or more possible investments. In the second company two investments were identified as beneficial in meeting the agreed Business Needs of the Company and after discussion within the Company, the financial evaluation of a coherent programme was undertaken.

In both companies the use of Pro-formas for the collection of the required data was stated as helpful. The Toolkits, which provided explanations on the procedures involved in the methodology, proved invaluable. Because many of the solutions sought were non-algorithmic the use of Workshops, to discuss, exchange and agree on ideas, viewpoints and decisions in an egoless environment, increased the commitment and sense of ownership to the process.

## **Chapter 11.0 Conclusion**

This work has provided a new process methodology for the cost justification of investments in new manufacturing tools, techniques and technologies for small and medium manufacturing enterprises (SME's), that should enable the company wide benefits and costs of new investment to be fully appreciated.

According to Coleman [114], "there are many appraisal techniques available and in use, but none of them seems to offer the complete solution". The process methodology developed through this research provides a highly structured approach that advises the user company on the collection, the required format and the timing of the information necessary to undertake three different analyses. The process encourages the user company to first identify its business needs and then the business processes that are capable of change. On this basis the methodology can both recommend a limited number of possible investments, based on the criteria specified by the user, and cost justify investments selected or proposed by the user.

The importance attached to defining a company's business needs in the short, medium and long term cannot be over stressed. For without such a definition, a company might select an investment, that although improving the short term profitability of the company, could, by failing to recognise the future demands of its customers, leave it vulnerable to its competitors in the long term. Conversely, looking at the long term at the expense of the short term view, is not desirable either. The PROFIT Methodology, by assisting a company to define its business needs, attempts to overcome this dilemma.

In addition, a company should consider the potential it has to change its business processes. There is little point in undertaking a full cost justification analysis of a

new potential manufacturing investment, if the user company is unable to make changes vital to the successful implementation of the investment.

The process methodology also improves ownership and commitment to the manufacturing solutions identified by fully involving relevant company personnel in the identification of business needs, the generation of solutions and the financial justification of proposed investments. Jardine and Gately [115] state, "Control and ownership must switch from vendor to business users and beneficiaries and that means the latter radically improving their understanding of both IT and what it can offer the business".

In addition, Lane [116] suggests that "Managers urgently need to have an appreciation of the business consequences of decisions which are often made at relatively inexperienced levels". The PROFIT process methodology provides a mechanism to facilitate management development and training in financial justification by providing rationales for each activity, Pro-formas for the collection of data and Toolkits to assist in the completion of tasks.

### **11.1 The PROFIT Methodology and Other Cost Justification Approaches**

The PROFIT Methodology has built on most of the advantages and addressed many of the deficiencies inherent in the traditional cost justification approaches, as well as, those techniques developed in recent years.

The methodology differs from many recent developments, not only in its structure as a tool for cost justification of manufacturing investments, but also, in that it assists companies in identifying their business needs and in suggesting possible manufacturing investments from the plethora of options available. Unfortunately, PROFIT does not cover every conceivable manufacturing investment currently available, however, through its structured approach, a company could easily

apply the reasoning and step by step method behind the process, to incorporate other manufacturing investments in the future.

Although the PROFIT Methodology can be applied in the form of the Workbook, its use in the form of a computer based tool (CBT) will greatly enhance its application and scope. Because much of the analysis relies heavily on performing calculations and undertaking 'what if' scenarios, which may become repetitive and time consuming, the CBT enables the cost justification analysis of one or a coherent programme of investments to be undertaken with greater ease, speed and accuracy.

## **11.2 Contribution of the Work**

The work has provided an improved approach for the cost justification of new manufacturing investment in SME's. The improved approach is directed at SME's and not large manufacturing enterprises.

The major contribution of the research lies in the development of a new methodology which incorporates many new ideas that significantly improve its value over current approaches. Particularly, the PROFIT Methodology:

- Provides a process methodology that allows for analysis of both discrete investments and coherent investment programmes.
- Identifies and structures the links between business needs and investments in manufacturing tools, techniques and technologies.
- Provides detailed guidelines on how appropriate manufacturing solutions can be identified to address business needs.
- Improves ownership and commitment to the manufacturing solutions identified by fully involving relevant company personnel in the identification



of business needs, the generation of solutions and the financial justification of proposed investments.

- Provides a mechanism to facilitate management development and training in financial justification by providing rationales for each activity, pro-formas for the collection of data and toolkits to assist in the completion of deliverables.

### **11.3 Future Work**

Future work will contribute to the identification of other manufacturing investments with their 'company wide' benefits and costs. This will further develop the process methodology's scope and application.

The Toolkits, which provide guidance to the users of the methodology, may be improved, particularly those relating to the identification of benefits and costs, as experience of a wider range of circumstances is gained.

The PROFIT Methodology relates primarily to SME's in the manufacturing sector, further research could determine approaches applicable to retailing, farming and horticulture, service industries, Banking and finance houses. The PROFIT Methodology, from the results of the tests carried out from data supplied by the two test companies, has been shown to be applicable in its current format for use by both SME's and large manufacturing enterprises, however, to extend the use of PROFIT to other businesses, further work would be required.

The PROFIT Methodology currently provides a training mechanism for managers in understanding the cost justification process, further work could improve the scope of the PROFIT Methodology as a training tool for students in educational establishments.

By presenting the Workbook in the form of a Computer Based Tool (CBT) would encourage its application amongst a wider section of businesses.

Further research could identify whether it is beneficial to encourage customisation of the PROFIT Methodology by the Companies themselves. The possibilities of increasing the database to incorporate further investments and benefits has already been discussed, but some companies may consider it necessary to customise other parts of the PROFIT Methodology, such as, the data collection contents and formats, the detail involved in the process methodology, should this be the case the question then becomes how much control, if any, should the user be allowed?

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**Appendix I**

**Figures.**

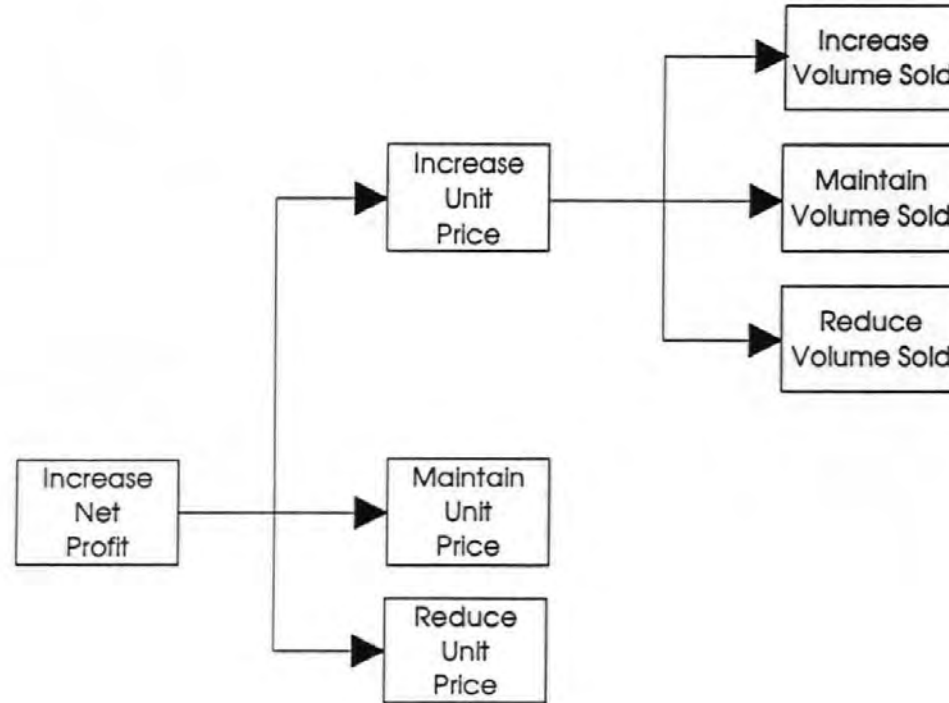


Figure 25 Change Sales Revenue - Overview

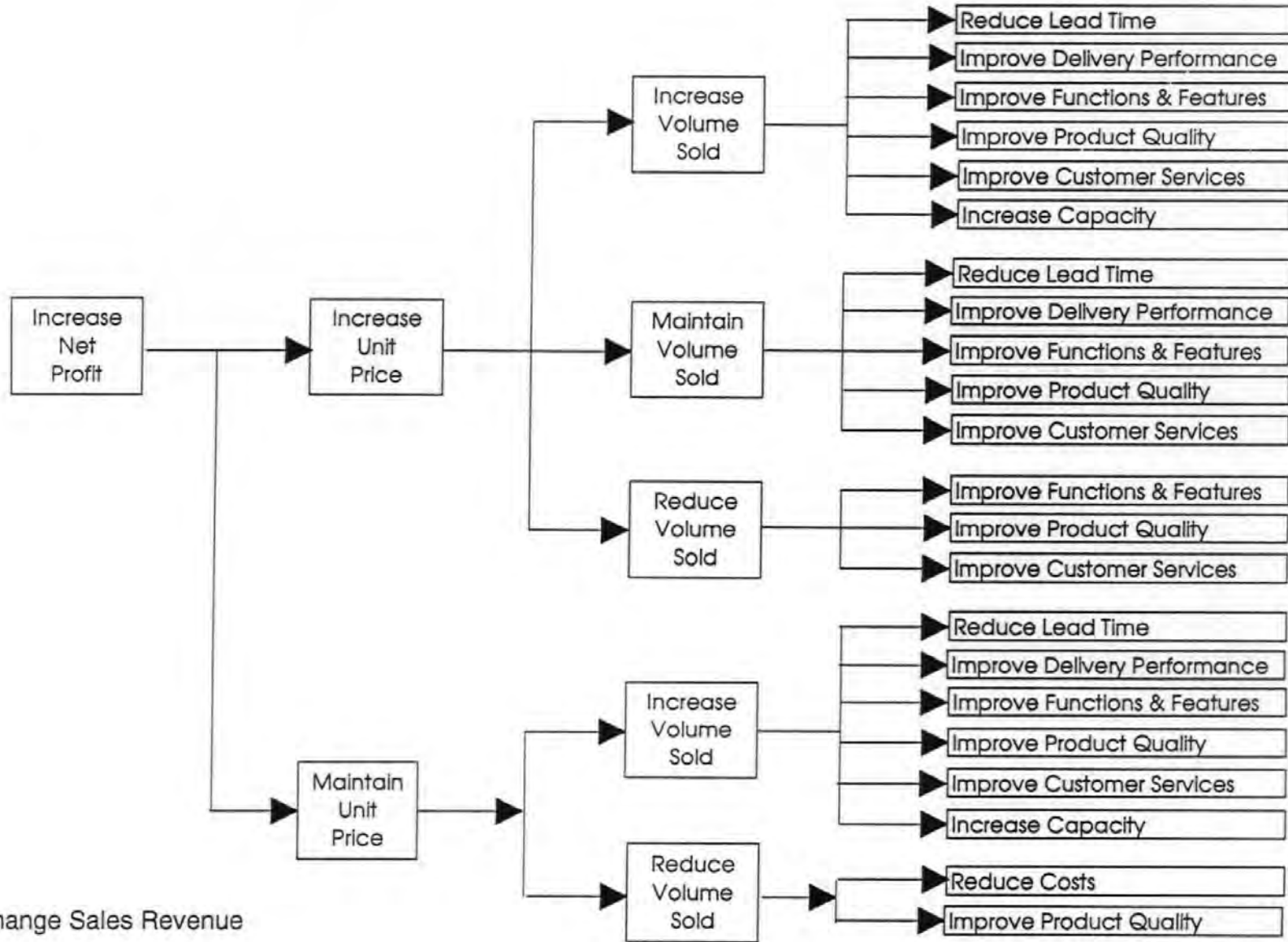


Figure 26 Change Sales Revenue

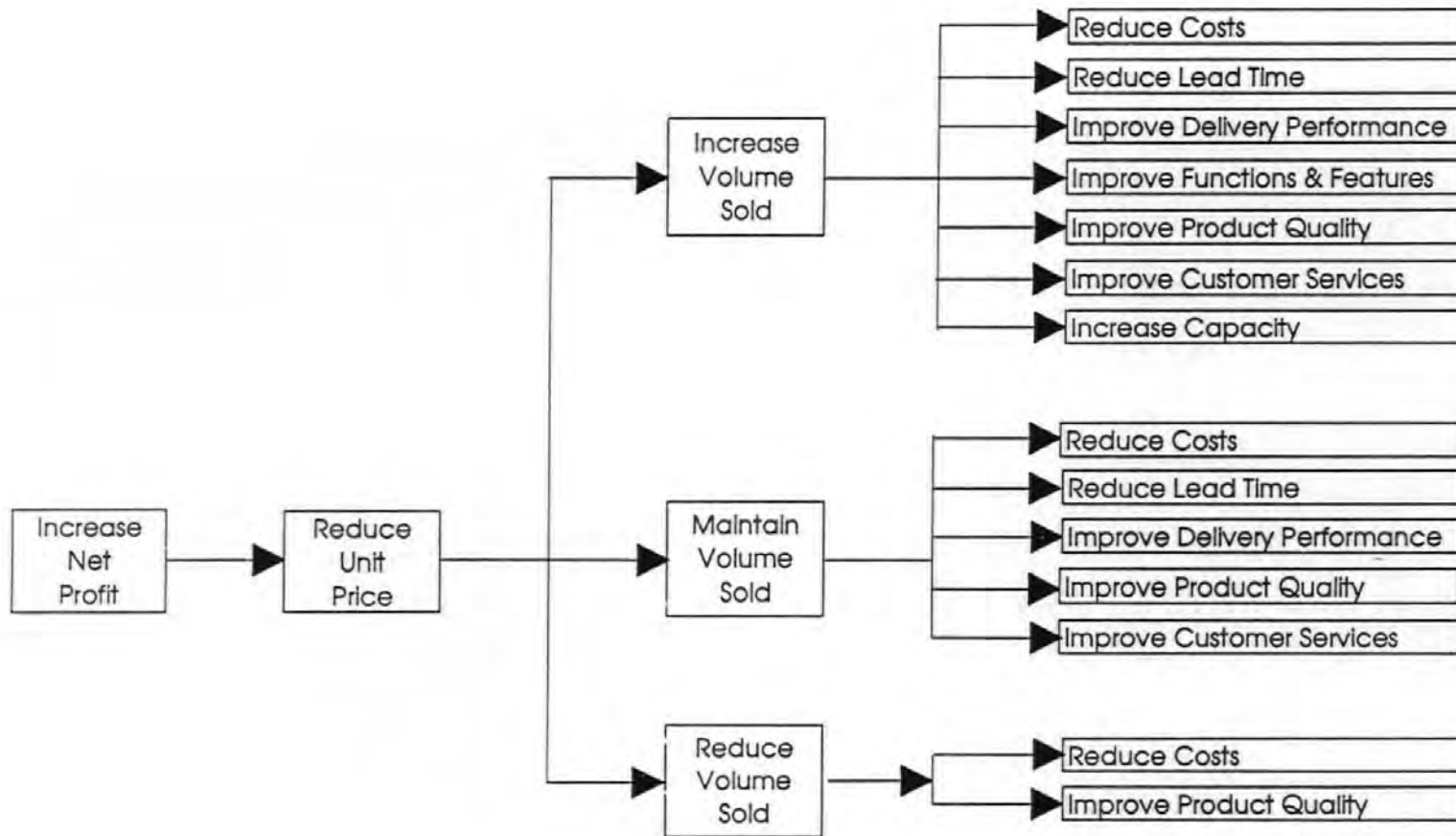


Figure 27 Change Sales Revenue



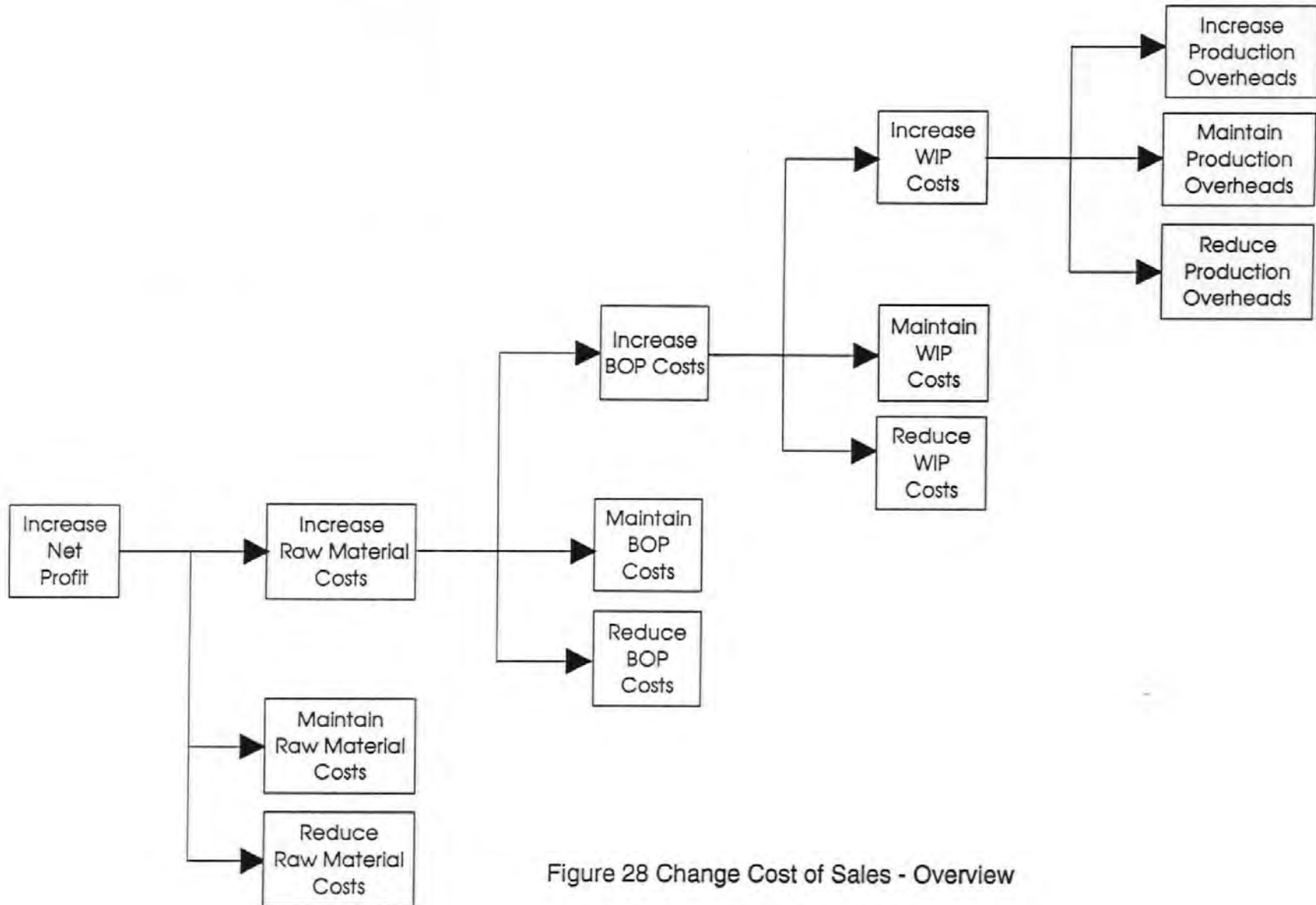


Figure 28 Change Cost of Sales - Overview

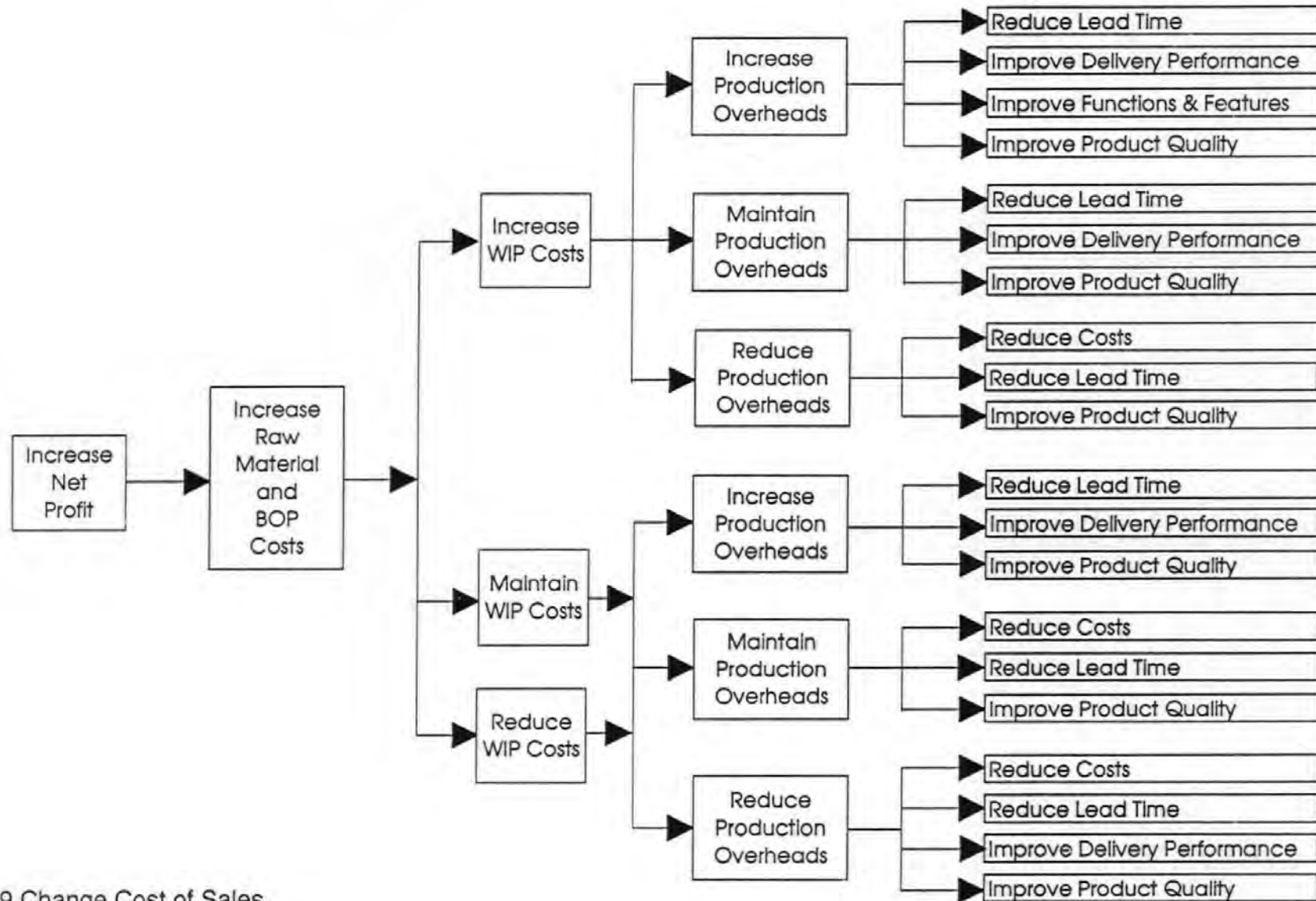


Figure 29 Change Cost of Sales

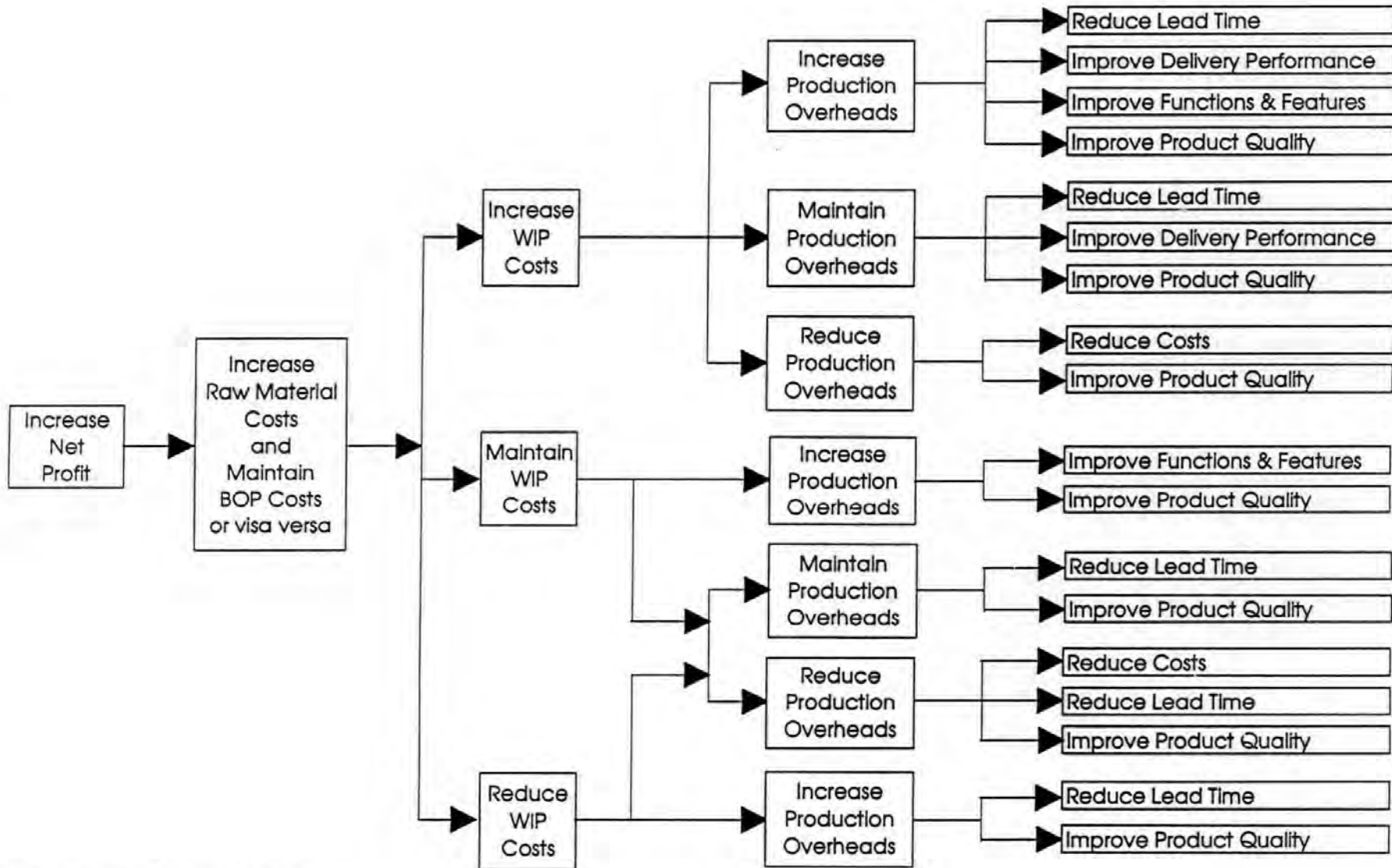


Figure 30 Change Cost of Sales

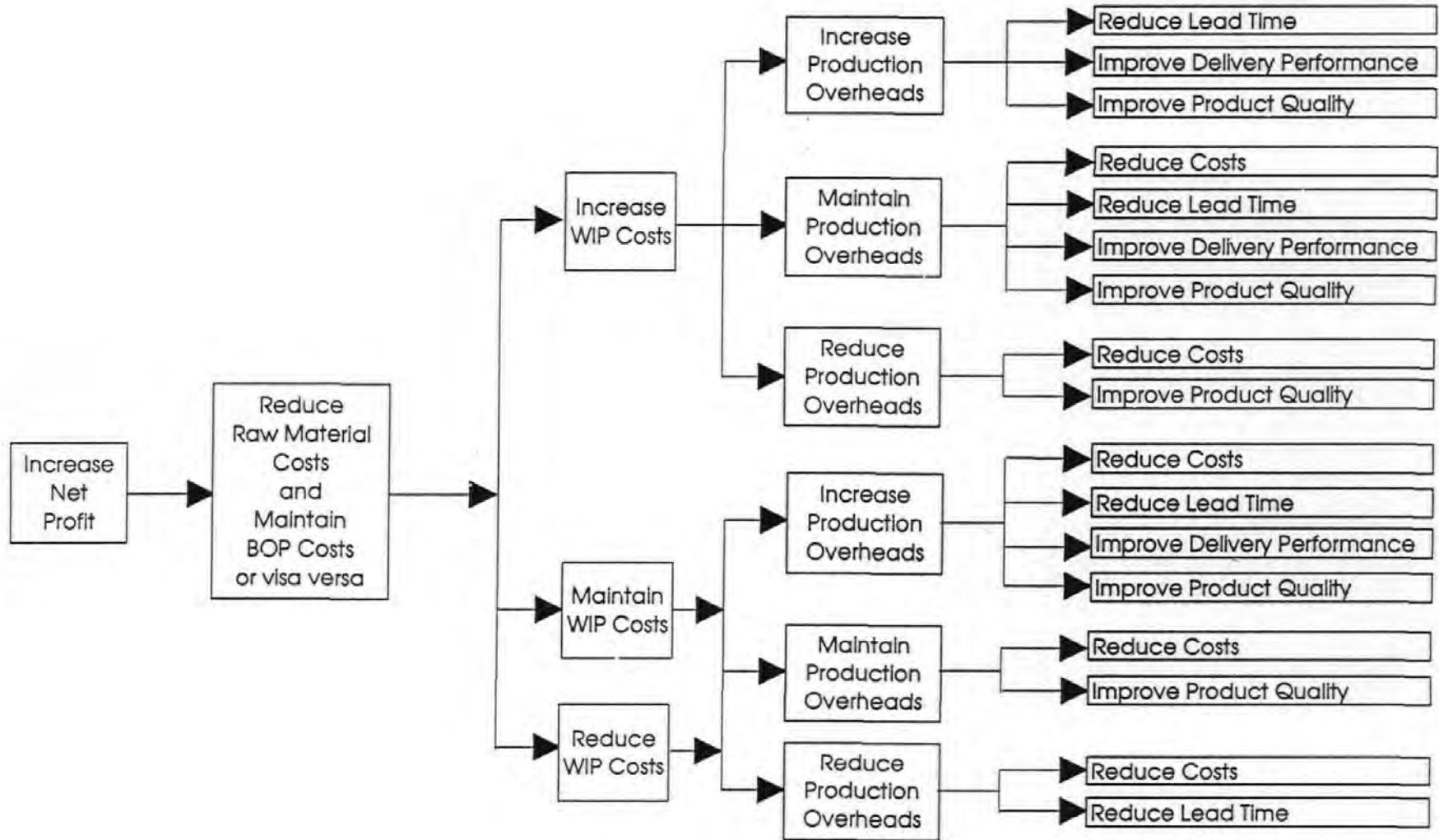


Figure 31 Change Cost of Sales

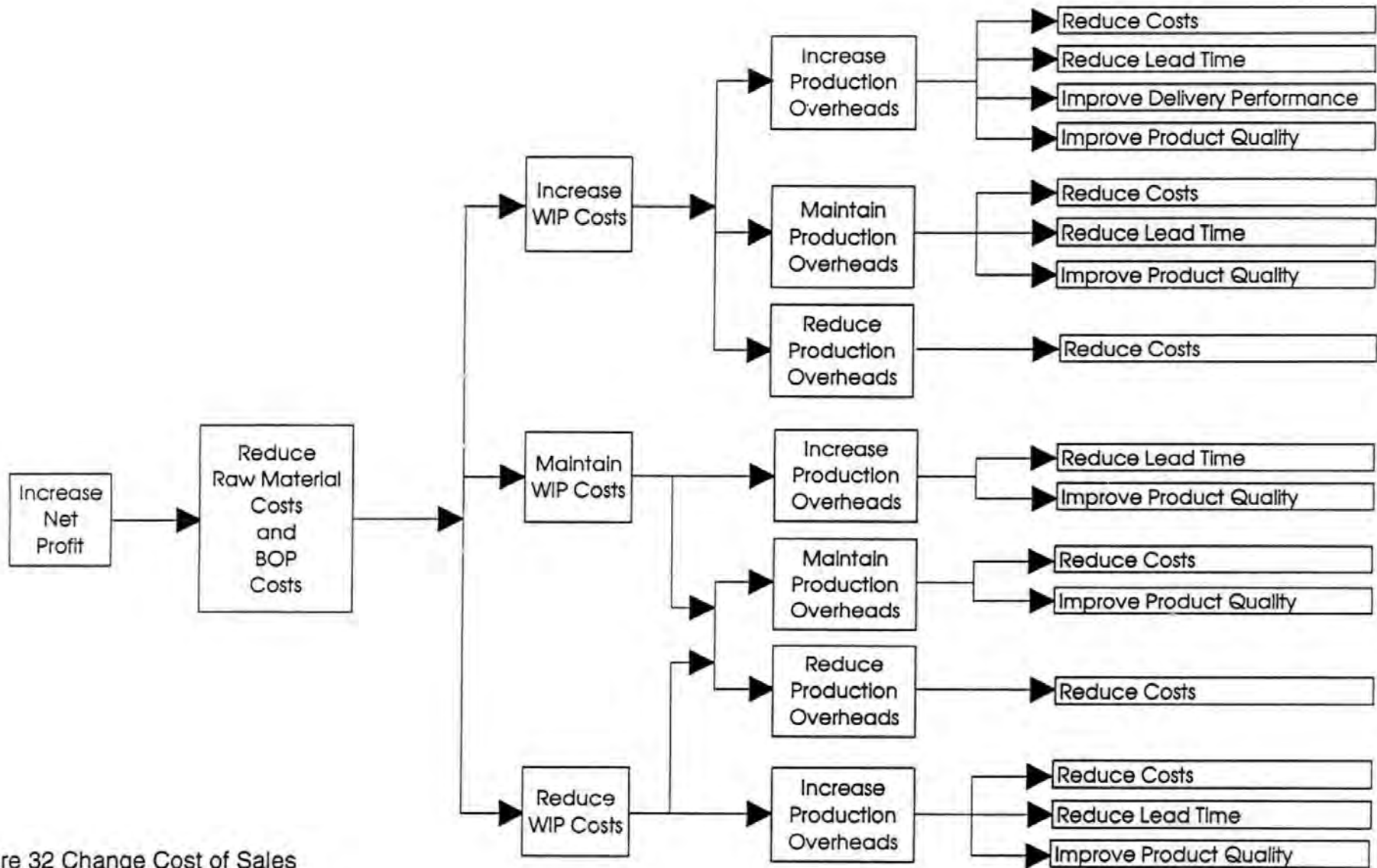


Figure 32 Change Cost of Sales

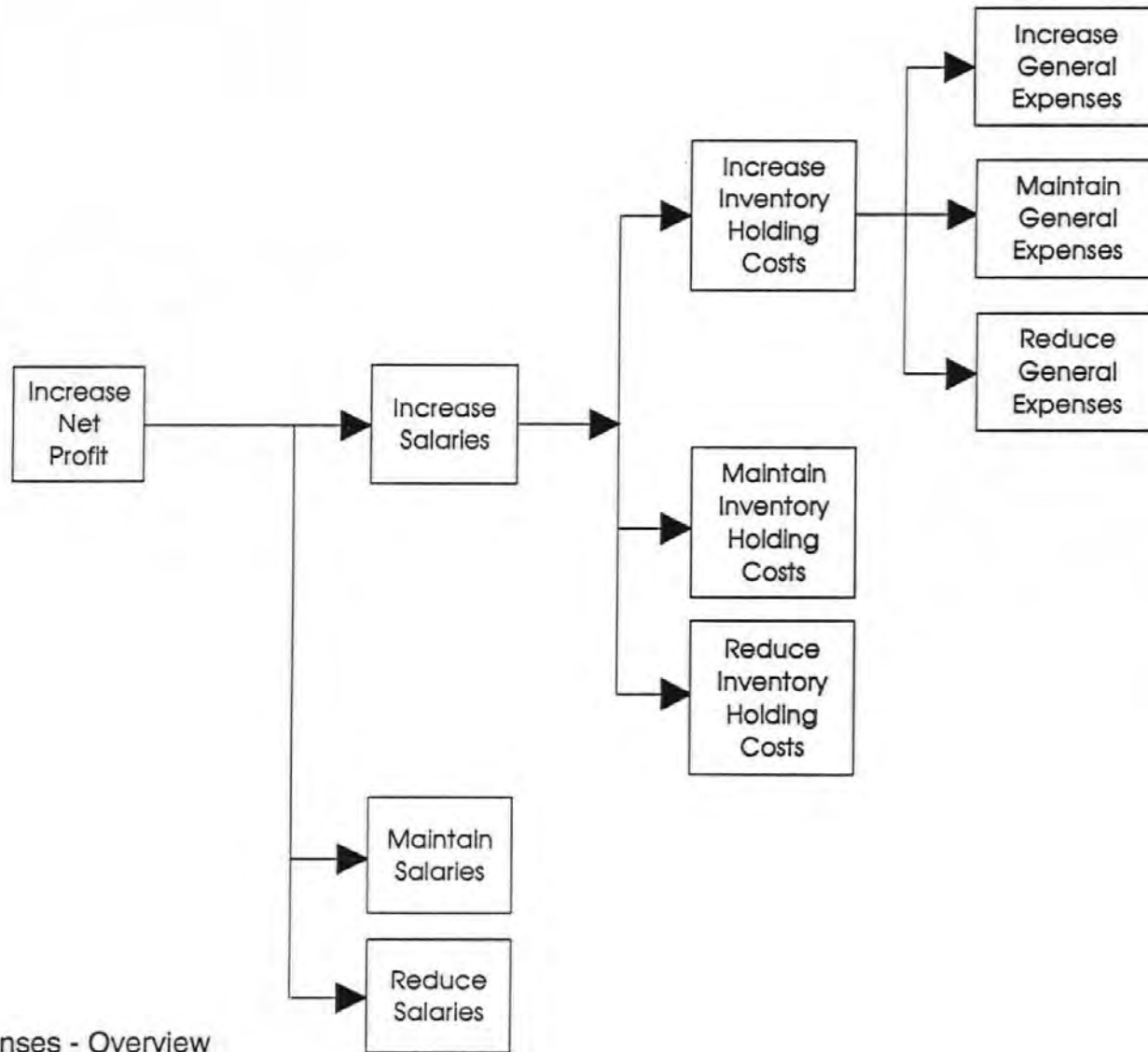


Figure 33 Change Expenses - Overview

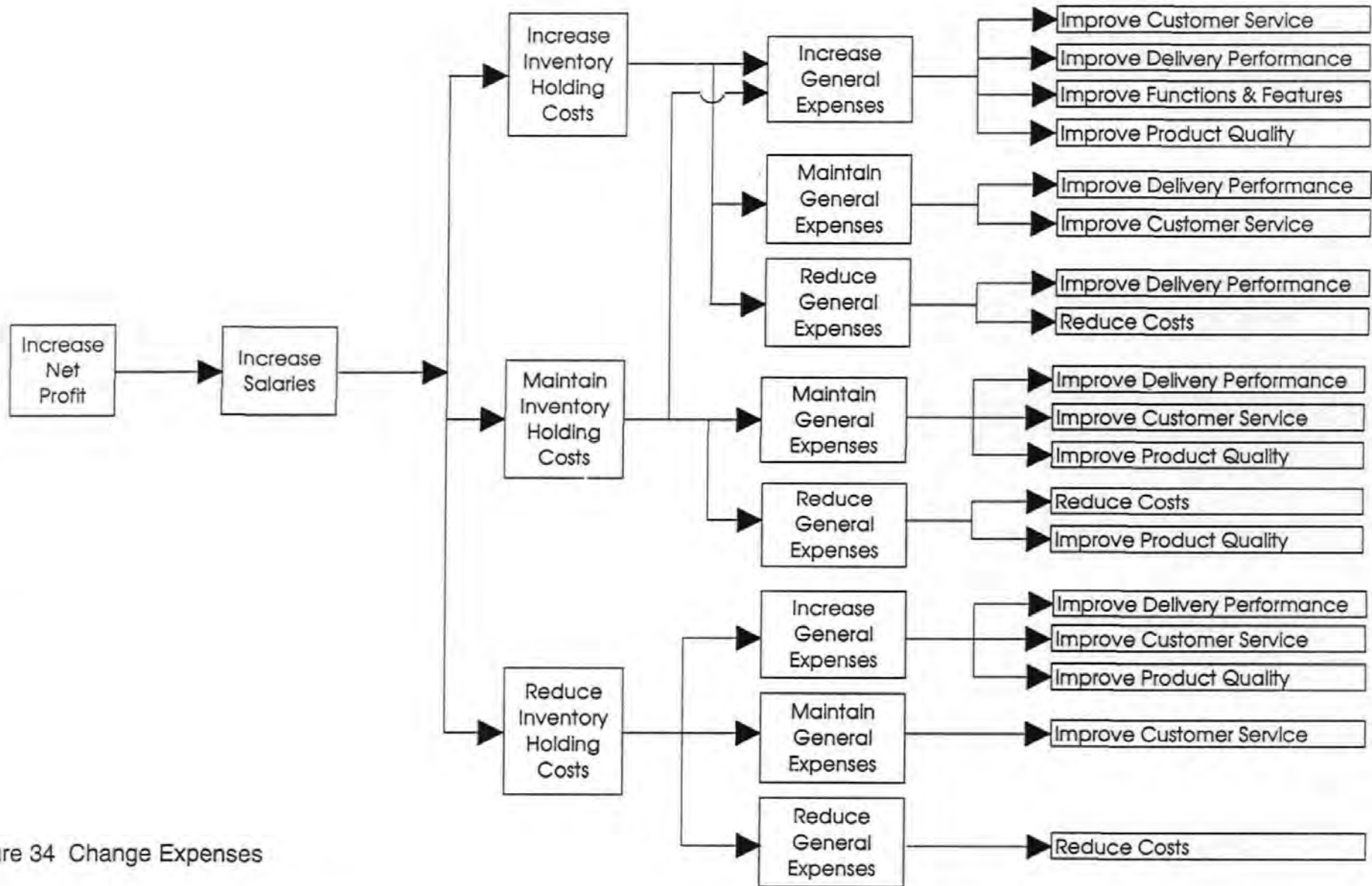


Figure 34 Change Expenses

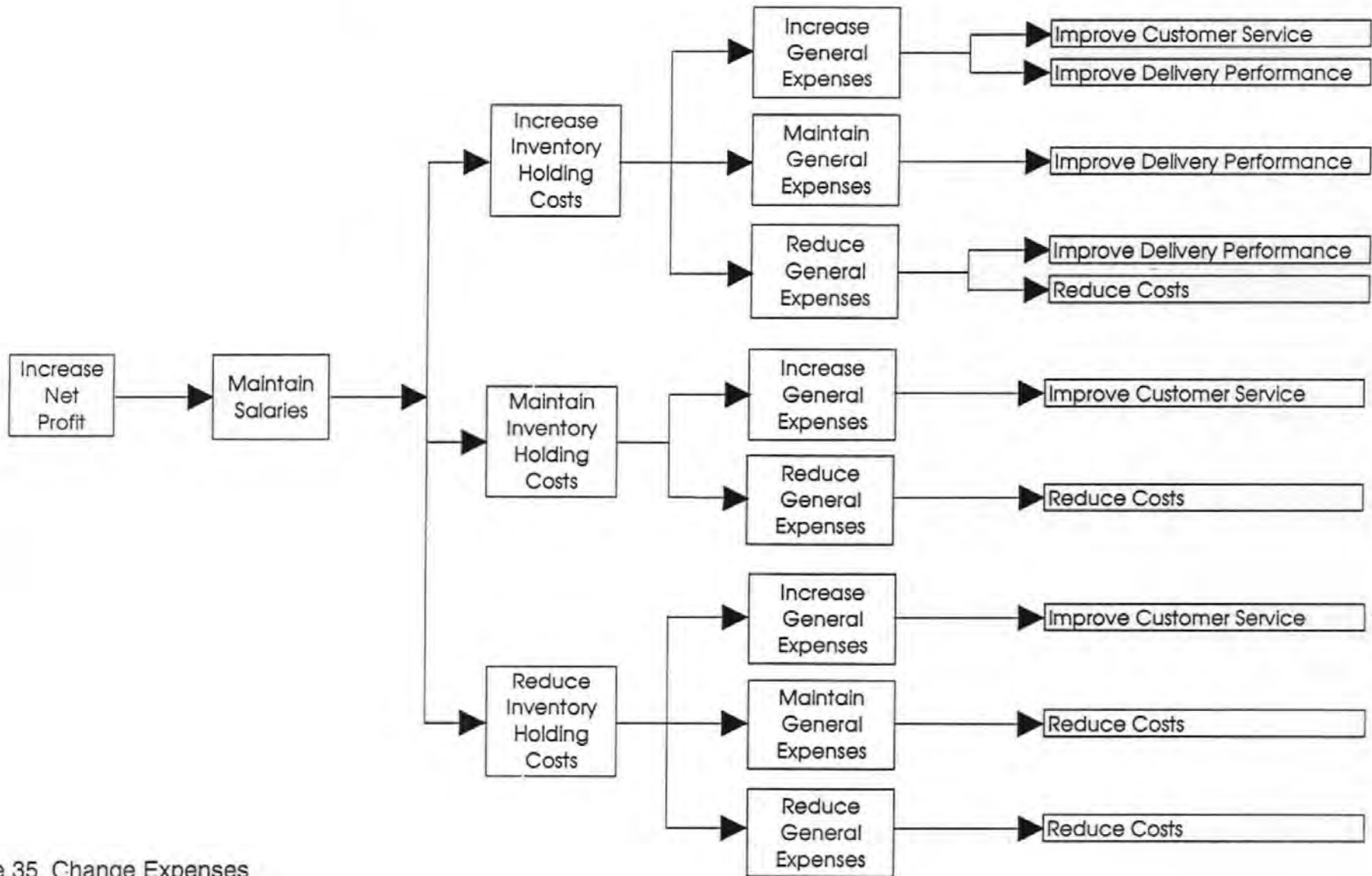


Figure 35 Change Expenses



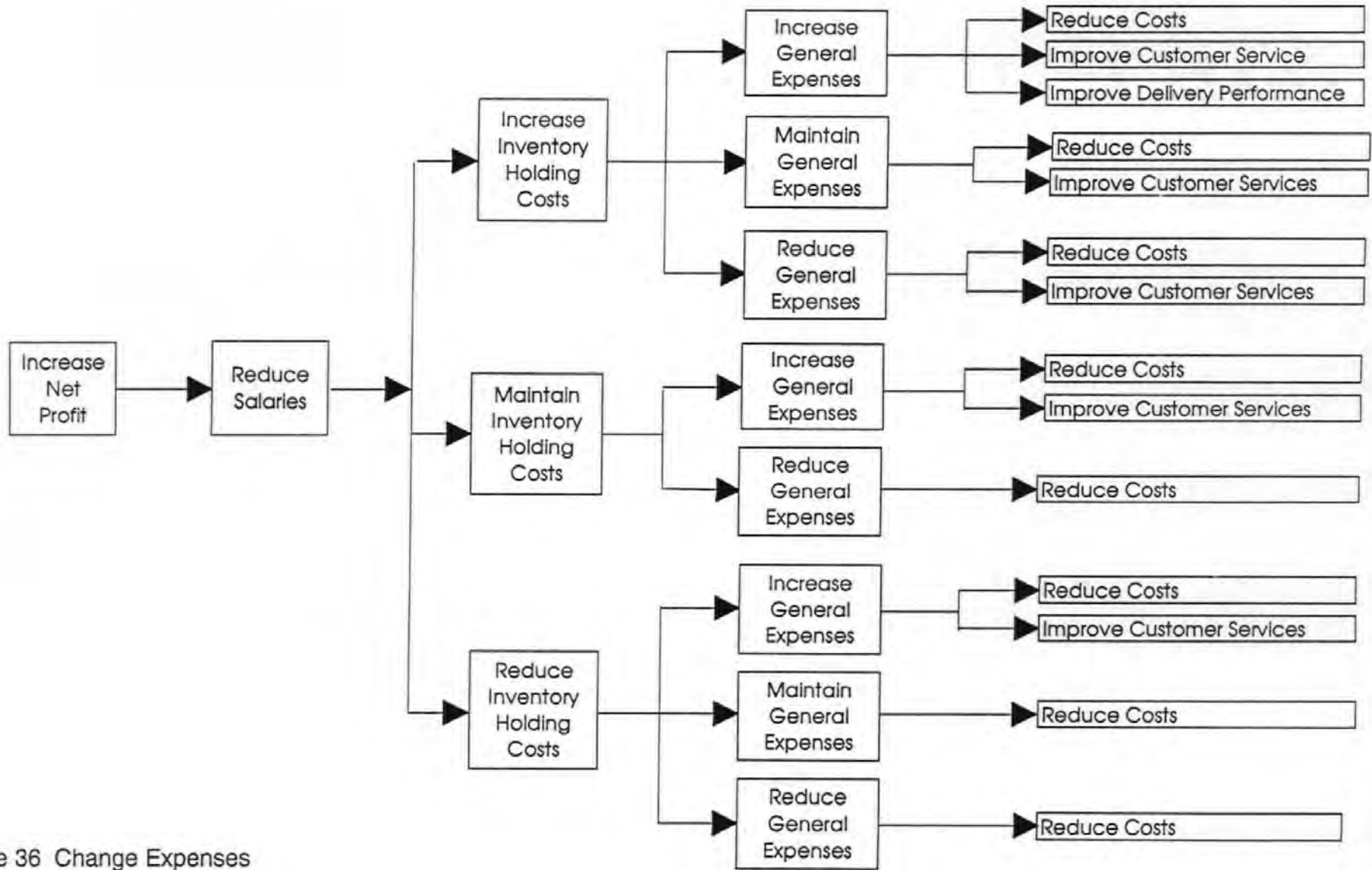


Figure 36 Change Expenses

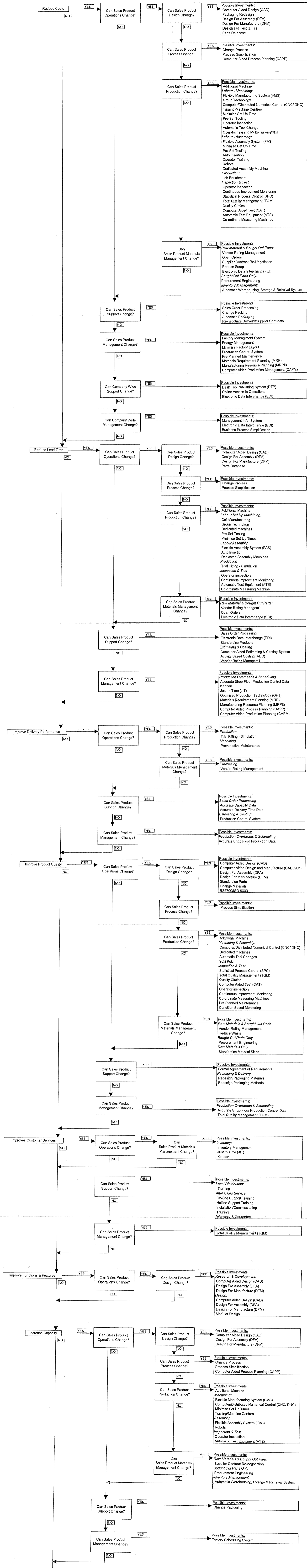


Figure 37 Identifying possible investments.

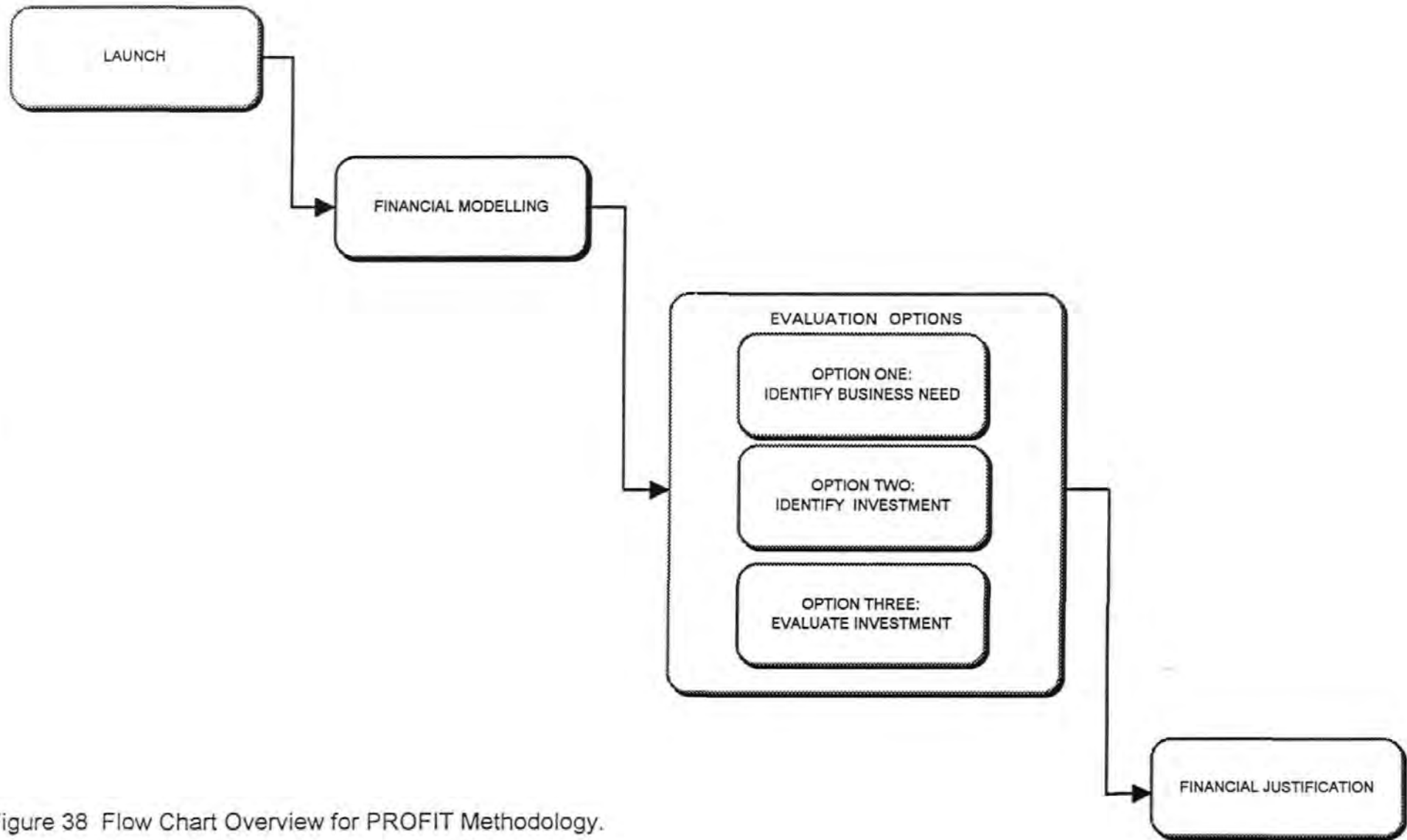


Figure 38 Flow Chart Overview for PROFIT Methodology.

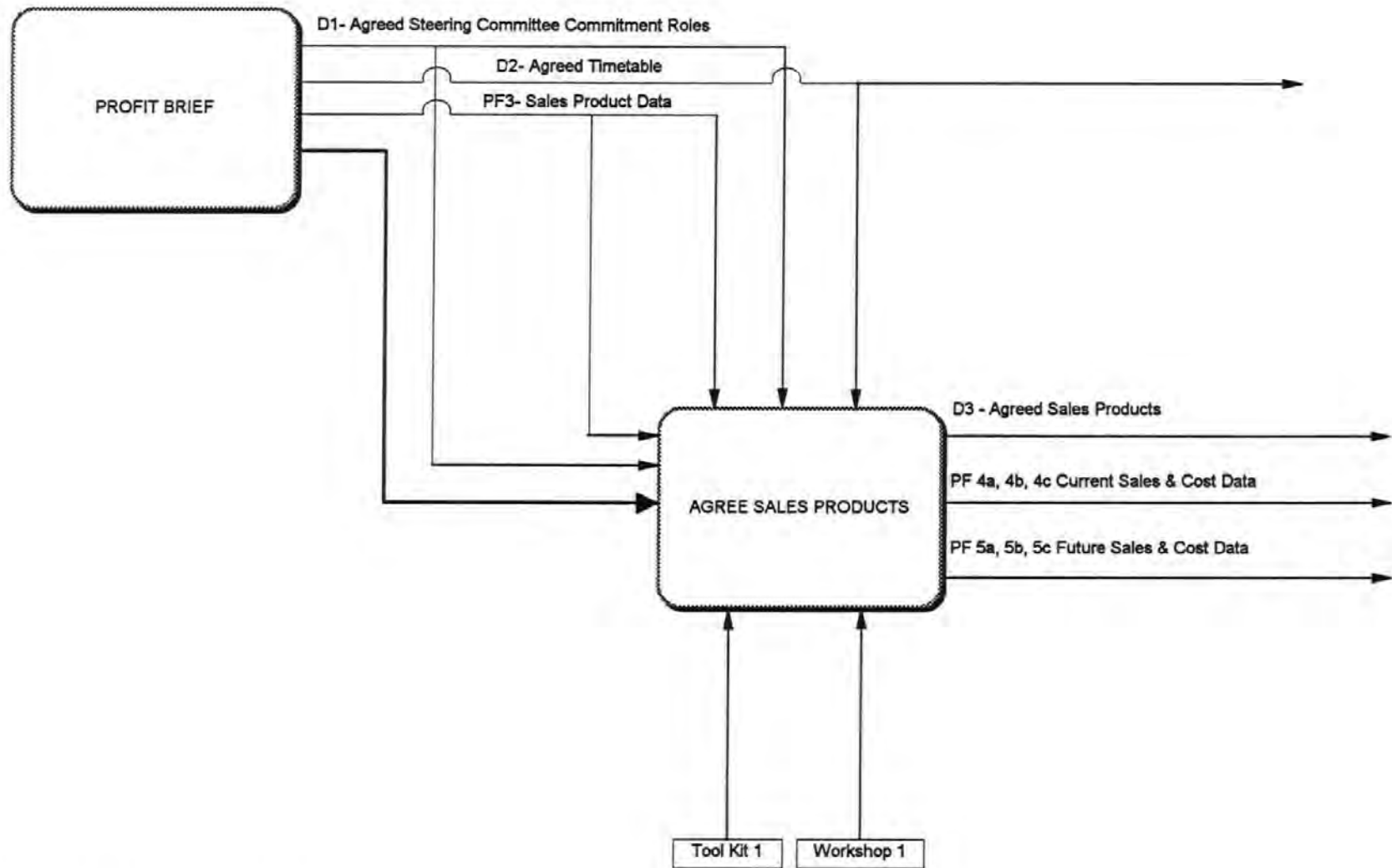


Figure 39 Flow Chart Stage One PROFIT Methodology.

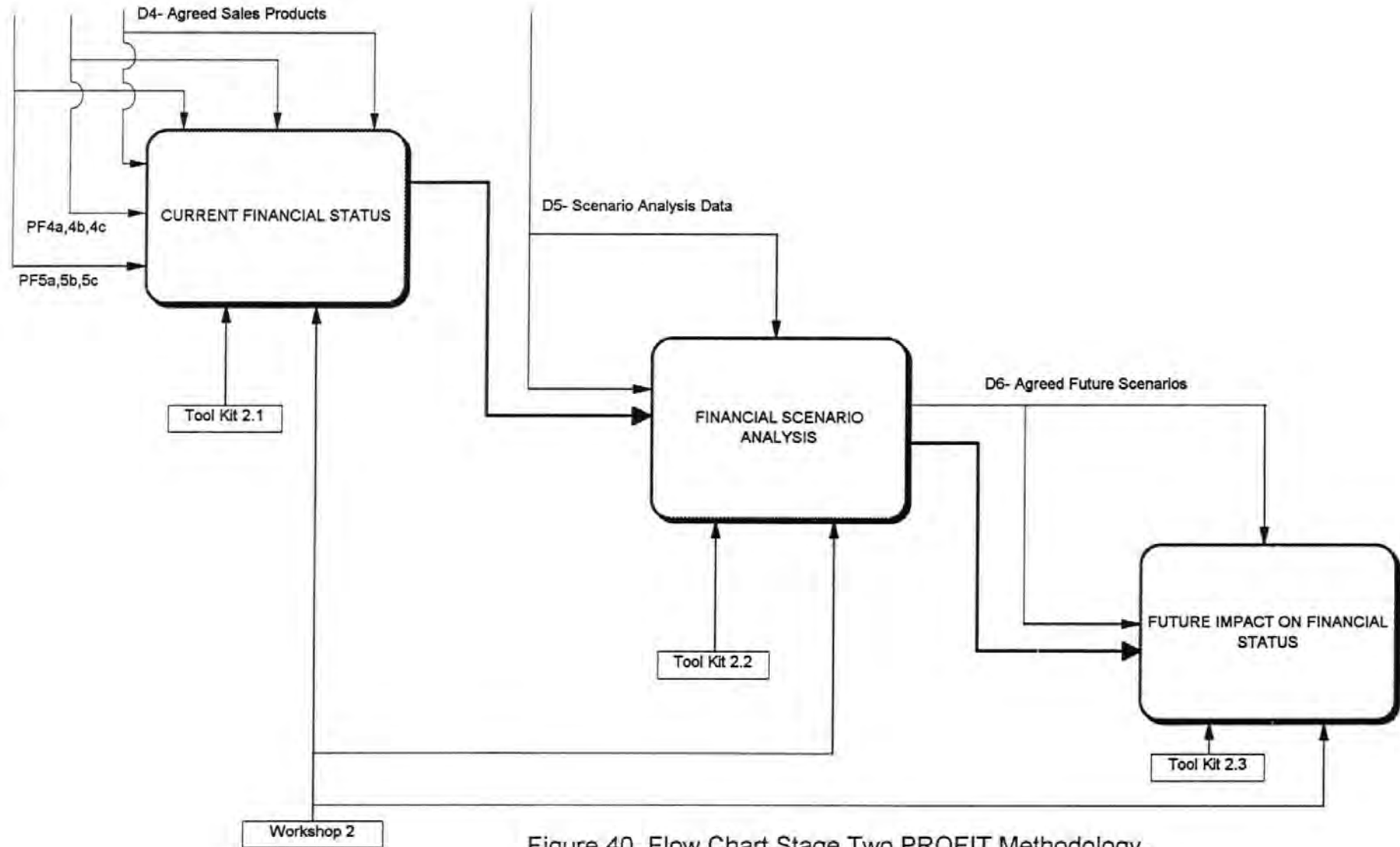


Figure 40 Flow Chart Stage Two PROFIT Methodology.

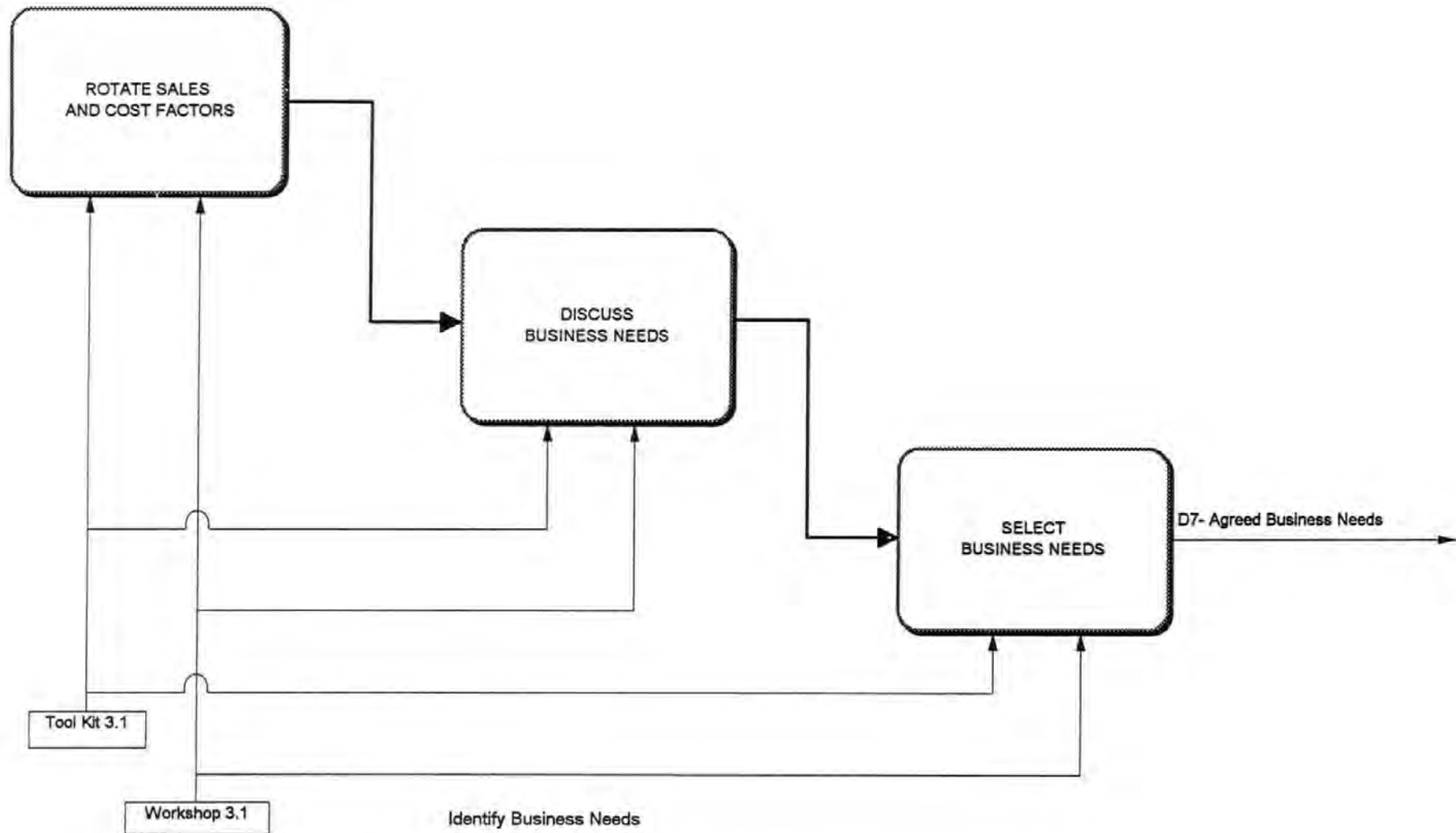


Figure 41 Flow Chart Stage Three - Option One PROFIT Methodology.

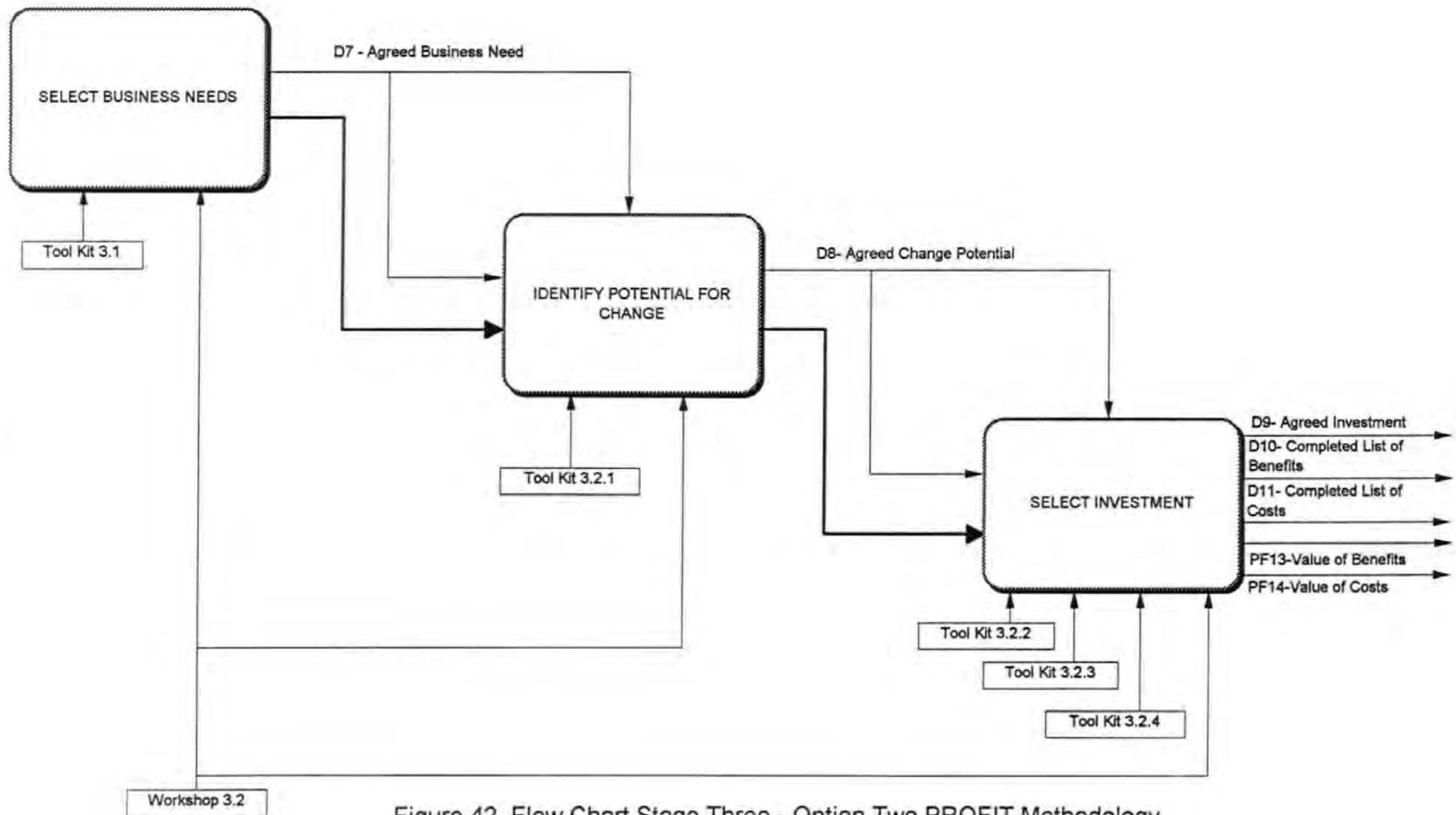


Figure 42 Flow Chart Stage Three - Option Two PROFIT Methodology.

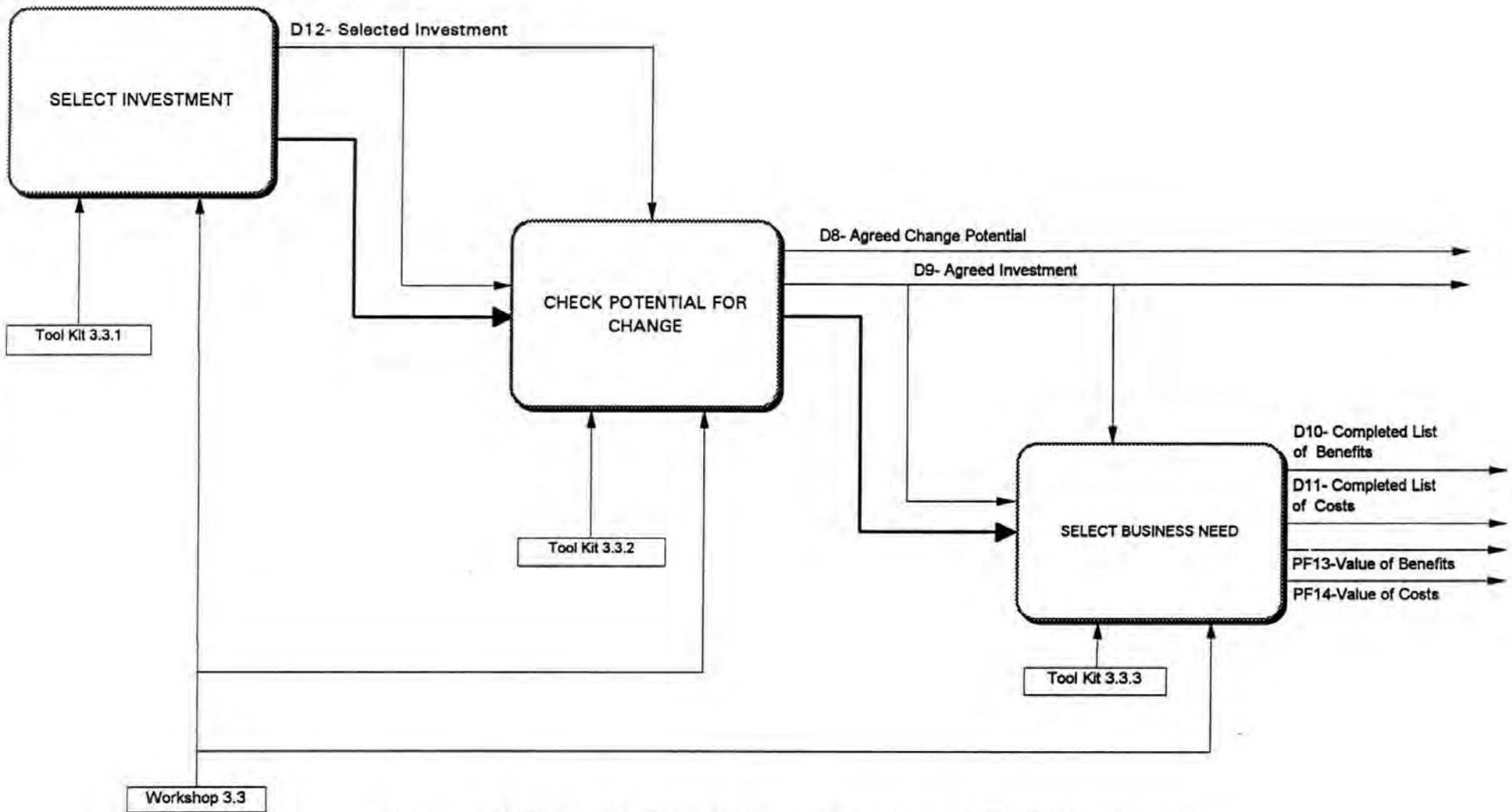


Figure 43 Flow Chart Stage Three - Option Three PROFIT Methodology.



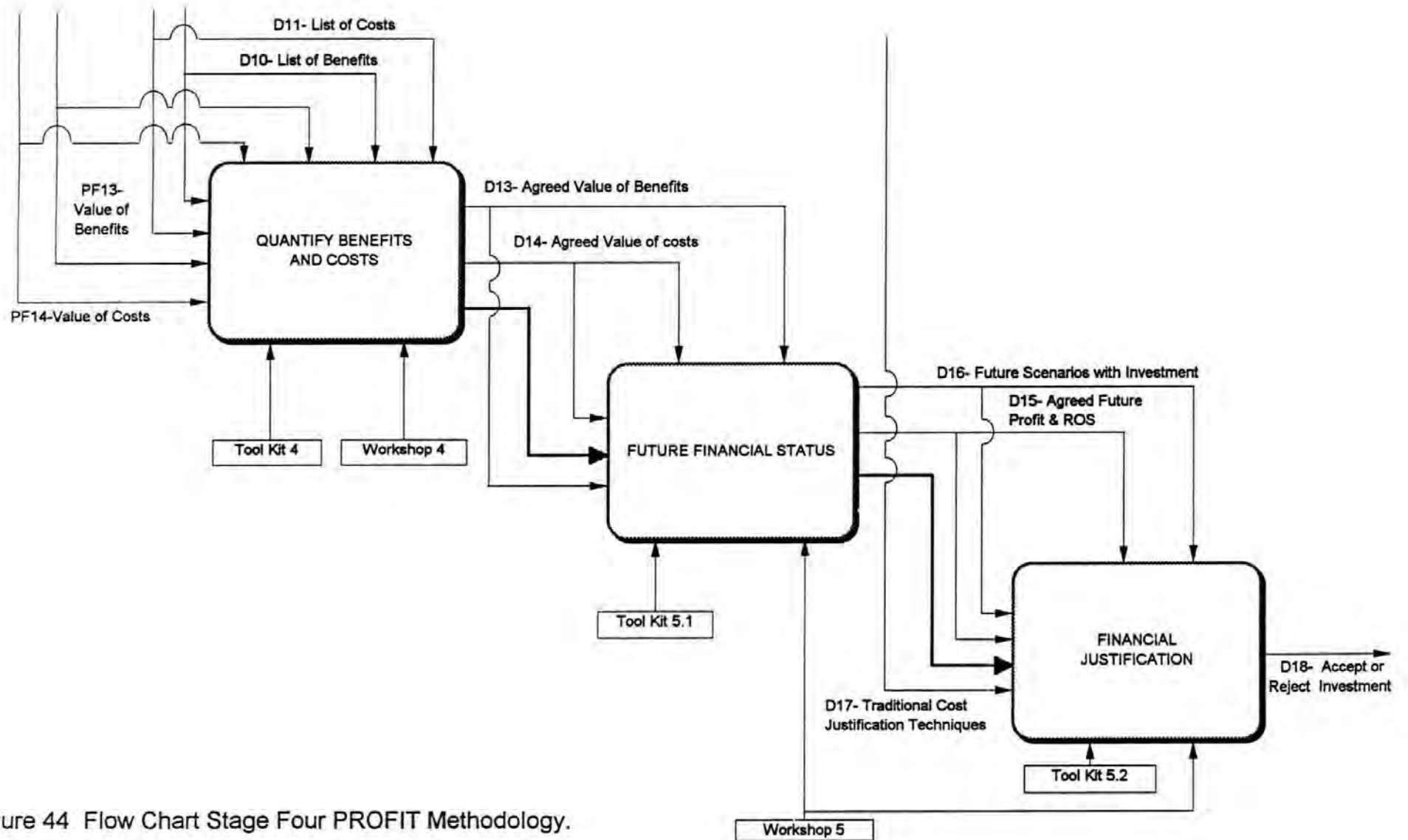


Figure 44 Flow Chart Stage Four PROFIT Methodology.

**Appendix II**

**Papers**

**Papers relevant to this work,  
published and/or presented at Conferences.**

**Fourth International Conference on Productivity and Quality Research**

Miami, Florida, USA, February 1993.

DEVELOPMENT OF A USER LED METHODOLOGY FOR THE SELECTION OF  
QUALITY AND PRODUCTIVITY IMPROVEMENT PROGRAMMES

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ABSTRACT

The requirements that face modern manufacturing enterprises demands that a large number of improvement opportunities need to be evaluated. To ensure that the full implications of each alternative are considered and important aspects are not overlooked, a well structured approach is required. The approach must be easily understood, make best use of valuable management time and be acceptable to a company's accountants and bankers.

The use of consultants to assist in the analysis of Quality and Productivity improvement programmes, although feasible to many large manufacturing enterprises (LME's) could prove prohibitively expensive to small and medium sized enterprises (SME's), restricting successful investment vital to their survival.

A new approach entitled PROFIT (PROgram for Financing Integrated Technologies) employs a methodology and AI tool which enables companies to evaluate one or more Quality and Productivity programmes, with little or no outside assistance. PROFIT involves six stages:

- Present company status analysis.
- Requirements for proposal and value to the company.
- Opportunities for company in the future.
- Future potential and compatibility of proposal.
- Identification of future value of proposal.
- Target requirements to be addressed and their real value to the business.

PROFIT expresses the 'company wide' benefits in terms of the Net Profit and can display the projected Profit and Loss accounts of a business for the short, medium and long term for the best, worst and expected scenarios.

Cost Justification, Investment Analysis, User Led Methodology, World Class Manufacturing (WCM), Advanced Manufacturing Technologies (AMT), Computer Integrated manufacturing (CIM), Quality, Productivity, Structured Approaches to WCM, CIM, AMT.

**7th Annual European Computer Conference, COMPEURO 93**

Paris/Evry, France, May 1993

# The Development of a Methodology and Computer Based Tool for the Cost Justification of World Class Manufacturing Tools, Techniques and Technologies.

Author: Povl C. Larsen

## Introduction

In striving to reach World Class Manufacturing status, companies are often faced with a numerous selection of various proposals to analyse. Without careful consideration of each proposal, a company could select an inappropriate proposal which fails during implementation or improves a business need that has not been identified as vital to achieving World Class status.

## Traditional Cost Justification Techniques

Traditional cost justification techniques such as payback period, net present value, internal rate of return and return on investment have their origins in the era of mass production of standardised, large batch size products, where direct labour accounted for 50% of product costs, high inventory levels were encouraged to safeguard the company against unforeseen problems and quality was inspected in.

With the implementation of Advanced Manufacturing Tools, Techniques and Technologies (AMTTT), it is no longer acceptable to apply traditional cost justification techniques because product cost structures are changing and are liable to continue to do so. Also, traditional methods tend to concentrate only in the area of implementation and often on a department or functional area basis resulting in inter-department rivalry which sometimes is not in the best interests of the business as a whole (Maull, Childe, Hughes, Bennet, Tranfield, Smith 1992). Furthermore, due to the difficulty involved in assigning a value to intangible benefits, such as improved lead time, quality, flexibility, etc., traditional cost justification techniques ignore their existence and rely solely on tangible, quantifiable benefits. Traditional cost justification techniques that rely on setting rates of return that must be exceeded by any improvement proposal before it can be accepted, by their very nature, encourage management to set the rate high in a misguided attempt to protect themselves or the company in case of future adversity. The high rate of return approach also favours those proposals that offer the greatest short term return at the expenses of medium to long term strategic issues.

## Alternative Cost Justification Techniques

Many alternative cost justification techniques suggest the use of benefit analysis. Benefit analysis can be described as (Noble 1989) a technique that requires the users to assign a weight to the strategic objectives of the company, then rate them on the basis of their ability to meet the company objectives with and without the proposal, multiply the weights by the rates to obtain a score. The total scores indicate the relative merits, of both the current situation and the proposal, in meeting the company's objectives. The highest score is the option to select. Through the application of weights and rates these techniques sanction individual preferences that need not, necessarily, represent the best interests of the company and this is a major disadvantage of such techniques.

A computer investment program entitled IVAN (Primrose 1990) allows engineers to evaluate proposals prior to implementation using estimated data. IVAN has redefined many intangible benefits enabling their quantification. IVAN employs a check list that requests data from the user regarding costs and benefits of the proposal. Because the data values requested are not specific, upper and lower levels are established by the user, resulting in output by IVAN of three discounted cash flow returns. It is then left to management to establish the probability of the results and whether or not to proceed with the proposal. As no help is provided by IVAN in assisting management to reach a decision, the temptation for management to revert to the old tried and tested methods of exceeding a pre-determined rate of return still exists. IVAN merely providing new figures, faster.

The use of consultants to assist in the analysis of AMTTT(s), although feasible to many large manufacturing could prove prohibitively expensive to small and medium sized enterprises, restricting successful investment vital to their survival.

### **Development of a Methodology in the Form of a Computer Based Teaching (CBT) Tool.**

The CBT tool should;

- # be geared to the needs of the users to avoid some of the pitfalls of those systems used by vendor based consultancies, which can lead companies into the situation where they are trying to fit their company to the operating concept of the consultants/vendors software, which may not be beneficial to the company and may generate friction.(Childe 1991).

- # be easy to understand with on screen help facilities to guide the novice user through the program.

- # be user friendly, to encourage its use by a wide range of users.

- # require the minimum of training to avoid wasting valuable management time.

- # be capable of being run on personal computers.

- # be affordable to small and medium sized enterprises

The methodology should;

- # be based on sound accounting principles to be acceptable to the company accountants and the company's bankers.

- # be able to assist the users in identifying and quantifying the effect on the company as a whole at present and not restricting benefits to the area of implementation.

- # recognise that product cost structures in manufacturing today will change and in many cases already have. Frequently material costs account for 55%, replacing direct labour as the highest percentage of product costs, followed by overheads totalling 20% and indirect labour 15%. Leaving direct labour with only 10% of product costs.(Curtin 1984)

# overcome the need to set high rates of return to cover the company in case of adversity and redress the tendency to seek short term solutions.

The building of such a methodology and CBT tool for the cost justification of AMTTT(s) forms the basis of a new structured approach, entitled PROFIT (PROgram for Financing Integrated Technologies), being developed at The Centre for Research into World Class Manufacturing at the University of Plymouth.

Because, the preparation of the profit and loss account is required by all businesses and is universally recognised by bankers, accountants and businessmen, PROFIT uses the profit and loss account as the basis for its analysis at present and projected versions for the short, medium and long term.

To overcome the disadvantages associated with department or functional area analysis PROFIT utilises the CIM Open Systems Architecture (CIM OSA). CIM OSA forces the user to think in terms of business processes rather than in terms of organisational functions or departments and thereby overcomes the tendency to develop 'islands of automation'.(Jorysz and Vernadat 1990). The structure of a manufacturing business can thereby be represented by:

- \* Management
- \* Operations
- \* Support

#### Operation Processes

- \* Product Design
- \* Process Design
- \* Production
- \* Materials Management

#### Support Processes

- \* Finance
- \* Personnel
- \* Facilities
- \* Information Services

#### Management Processes

- \* Scheduling
- \* Business Planning

#### The PROFIT Methodology

The PROFIT methodology has identified six principle stages in the evaluation of improvement programmes. They are:

- Present company status analysis.
- Requirements for proposal and value to the company.
- Opportunities for the company in the future.
- Future potential and compatibility of proposal.
- Identification of future value of proposal.
- Target requirements to be addressed and their real value to the business.



## **Present Company Status Analysis**

The first stage of PROFIT requires the users to analyse the company at present, for either a product family or on a company wide basis. The PROFIT methodology distinguishes between product families and company wide analysis, on the basis that analysis of product families allows for changes in the products' physical form, while company wide analysis concentrates on changes to the business processes. Present company analysis involves inputting data into a simplified profit and loss account spreadsheet. To assist the user in collecting the relevant data required, PROFIT provides on screen guidance in the form of Help screens. Having calculated the present company status, PROFIT requests data on up to five proposals. Only five proposals can be analysed because this number can be readily viewed on one screen. For each proposal the user is requested to identify the main business need the proposal addresses. For a product family there are seven possibilities:

- \* Reduce Costs
- \* Reduce Lead Time
- \* Improve Due Date Conformance
- \* Improve Quality
- \* Improve Functionality and Features
- \* Increase Volume
- \* Increase Flexibility

And on a company wide business only one business requirement, namely:

- \* Reduce Costs

## **Requirements for Proposal and Value to the Company**

Having organised the company on the CIM OSA basis, PROFIT, advises the user on the data required for the particular Business Requirement and type of analysis - Product Families or Company Wide.

If the analysis is to be based on Product Families, PROFIT displays a strategy for the Business Requirement selected that requires querying Operations. If the analysis is to be Company Wide based then PROFIT displays a strategy based on Support and Management.

From the strategy, the data collected is processed by PROFIT into Primary, Requisite and Consequential justifications.

**Primary Justifications.** These represent the justifications for the proposed improvement programme that directly address the activities the business must undertake.

**Requisite Justifications.** These represent the Critical Success Factors, those justifications that are vital to the success of the Primary justifications.

**Consequential Justifications.** These represent the justifications resulting from the proposed improvement programme, but that are not essential to achieve the strategy.

To calculate the present value to the company of the proposed improvement program, the value attached to the Primary and Consequential justifications are input into PROFIT's Profit and Loss Account. The cost of the proposed improvement programme is entered into the Profit and Loss Account as a finance cost to be depreciated over the relevant time period as dictated by the company policy. PROFIT then displays the Profit and Loss Accounts with and without the proposed improvement programme, providing virtually immediate display of the effect of the proposal to the user.

### **Opportunities for the Company in the Future**

The opportunities in the future for a company, involves identifying which items in the Profit and Loss Accounts are likely to be influenced by external causes, such as changes in Government legislation, market trends, quality standards, health and safety laws and public action groups. PROFIT provides assistance to the users through its on screen help. On reaching consensus on the external influences, guidance is provided from within PROFIT on establishing the expected value of each of the external influences. Two further values for each external influence are next input, one for the worst scenario likely and one for the best.

### **Future Potential and Compatibility of Proposal**

On input of the required data, PROFIT displays three profit and loss accounts. One for the best, worst and expected future scenarios for each proposal under audit. Consideration of the future potential of the proposed improvement programme can now be realised. At this point it is still possible to make alterations to any of the three profit and loss accounts displayed, if the users consider the results unlikely to be representative. Once the output has been agreed as truly representative of the data input, the compatibility of the proposed improvement programme for the future business requirements can be considered

### **Identification of Future Value of Proposal**

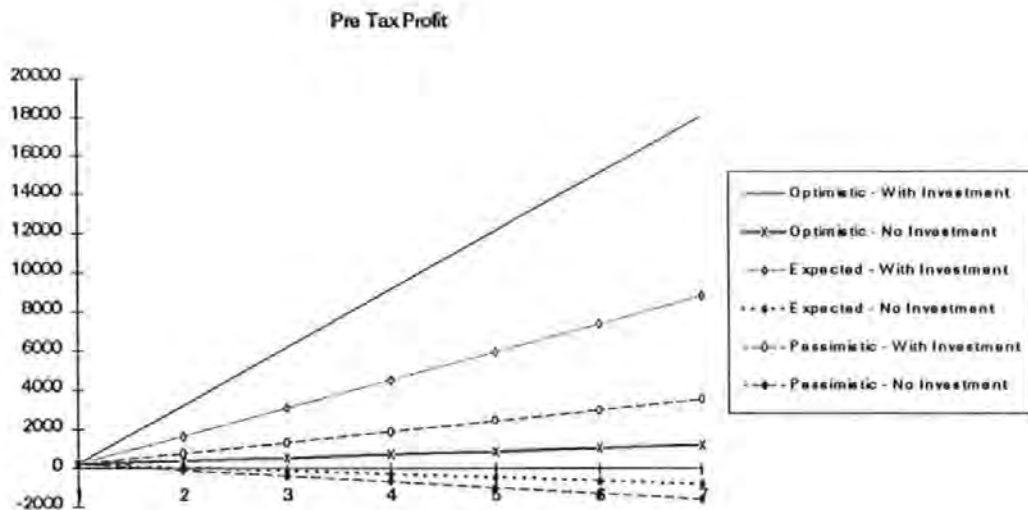
The future value requires identifying the future benefits that exist in addition to those already identified for the proposed improvement programme in the earlier stages of PROFIT and quantifying their value. PROFIT again provides on screen help and information sheets to assist the inexperienced user.

PROFIT then displays the data input in the format of six Profit and Loss Accounts, two each for the best, worst and expected scenarios, one without the proposed improvement programme and one with.

### **Target Requirements to be addressed and Their Real Value to the Business**

This last stage of PROFIT displays:

- \* The Business Requirement selected with a list of the Primary, Requisite and Consequential justifications for the present and in the future.
- \* Profit and Loss Accounts for the present, short, medium and long term, with and without the proposed improvement programme.
- \* Graphical representation of the expected profit or loss for the three possible scenarios with and without the AMTTT proposals, as illustrated below:



## Conclusion

The PROFIT methodology and software, being developed at The Centre for Research into World Class Manufacturing at the University of Plymouth, is currently being tested amongst small and medium sized manufacturing enterprises in the United Kingdom.

Through the use of the PROFIT CBT tool companies will be able to, without the need for external consultants, identify and quantify the true costs and benefits for a number of AMTTT(s) proposals.

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# **Development of a Methodology to Assist SME's to Identify CIM Technologies for Specific Business Performance Improvement Requirements.**

Povl Larsen and Prof. David Hughes.

## **ABSTRACT**

Where Small and medium size enterprises (SME's) have undertaken a comprehensive analysis of their present and future business performance improvement requirements, the identification and selection of the most appropriate method for meeting the said requirements can be a daunting experience.

SME's can find employing consultants, to assist them in identifying potential CIM Technologies, to be prohibitively expensive - preventing the SME's from investing in CIM Technologies that could be vital to their long term survival.

Without access to expert knowledge on the plethora of CIM Technologies available, SME's could select an inappropriate CIM Technology - one that rather than making them more competitive, has the opposite effect. and seriously hinders their performance.

To help overcome these potential problems, the Centre for Research into World Class Manufacturing, at the University of Plymouth, is developing a user led methodology to assist SME's in quantifying the most financially viable CIM Technologies. Through a structured approach, SME's learn how to identify and prioritise appropriate CIM Technologies for specific business performance improvement requirements, thereby, alleviating the need to employ outside consultants and ensuring that the full implications of each alternative are considered. The approach is based on the Profit and Loss Account and therefore is acceptable to the SME's accountants and bankers, can also be easily understood and makes best use of valuable management time.

The new methodology involves:

- Specifying the present SME's situation.
- Selecting and quantifying the present and future business performance improvement requirements.
- Selecting the future potential and compatibility of CIM Technologies.
- Quantifying the future value of the CIM Technologies.
- Summarising the business performance improvement requirements to be addressed and their real value to the business.

The methodology will express the 'company wide' benefits in terms of the Net Profit and will display the projected Profit and Loss accounts of an SME for the short, medium and long term for the best, worst and expected scenarios. It will also evaluate the cost of doing nothing and allows for the SME to make alterations and updates.

## **KEY WORDS:**

Cost Justification, Investment Analysis, User Led Methodology, World Class Manufacturing (WCM), Advanced Manufacturing Technologies (AMT), Computer Integrated manufacturing (CIM), Quality, Productivity, Structured Approaches to WCM, CIM, AMT.

**Papers accepted**  
**for publication, relevant to this work.**

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# CBT's - On Screen Simplicity Hides Off Screen Complexity

David R. Hughes and Povl C. Larsen

## Abstract

A recent research project undertaken by the authors has highlighted the value of methodologies, which whilst improving the performance of companies, also serve to educate and develop company staff in the tools, techniques and technologies required for success. A particular problem in small and medium sized companies is lack of skills, or the financial resources to acquire such skills, to cost justifying investments in their businesses. To address this problem the authors have developed an approach, supported by a computer based tool, to take companies through a structured process of identification of suitable investments and justifying their cost.

The principles underlining the development of computer based training (CBT) Tools is that they should be easy to use and simple to understand - no matter how complex the subject matter being dealt with. An analogy of the swan may be appropriate, its calm, peaceful appearance on the surface of the water as it floats gently along the river often belies the frenzied activity below water as it swims amongst currents and tides. In the early development phase of the CBT, the computer screens were laden with information to assist the user in completing the required tasks. Far from simplifying the use of the tool, the busy screens added to the apparent complexity. Users who tested the software, were overwhelmed by the amount of data required and became quickly disenchanted.

In developing a CBT for the cost justification of new manufacturing investments, the authors realised that it was vital to identify, not how much data was required on each screen, but how little.

The CBT concerned, utilised a modified Profit and Loss Account. Instead of entering data directly on to the main Profit and Loss Account, under the headings of sales revenue, raw material costs, WIP, direct labour, production overheads and expenses, data entry screens were constructed to enable the user to enter the data in its constituent parts, that is, Sales Revenue as volume of goods sold multiplied by the average unit price, raw materials as raw material unit cost multiplied by volume produced, etc. This 'focusing down' enabled the construction of simple, effective screens and laid the foundations for future changes to occur. For example, if a user wanted to know the effect that a 25% increase in sales revenue would have on the net profit of the company, then the user needs to know how the increase in sales revenue was brought about. If the increase was due to an increase in unit price then the cost factors in the Profit and Loss Account would remain unchanged. However, should the increase be the result of increased volume, then the cost of raw materials would increase, as would, WIP, direct labour and production overheads.

A similar 'focusing down' approach was adopted throughout the CBT, for selecting business needs, identifying the potential to change the business processes necessary to implement possible technologies and in the entering of cost and benefit data resulting from technologies identified as suitable for investment.

It is the intention of this paper to describe the processes adopted in 'focusing down' and how the approach was used to identify, not how much data, but how little was required on each screen. Also, to explain the difficulties encountered and how they were resolved.



**Factory 2000.**

York, England. June 1994.

# **PROFIT - Program for Financing Investments in Technology.**

Povl Larsen and Prof. David Hughes.

## **Abstract**

The paper reports the development and testing of a new methodology and computer based tool (CBT) which will enable manufacturing companies to identify their business needs, select appropriate tools, technologies and techniques and financially justify their investments.

The paper begins by outlining the rationale for the development of a new approach observing that the use of external consultants to financially appraise potential investments, although feasible to large manufacturing enterprises, often proves prohibitively expensive to small and medium enterprises (SME's). This greatly inhibits investments which may be vital to their survival. Unfortunately, to compound the problem many SME's who have correctly identified their business needs may be unaware of the plethora of new tools, techniques and technologies currently available.

As the result of such problems the development of a methodology supported by a computer based tool, PROFIT, PROgram for Financing Investments in Technologies, is reported. The methodology has been specifically designed to assist SME's to determine, for themselves, the full financial implications of investment in new technology. To ensure that the implications of each potential investment are considered and important aspects are not overlooked, a highly structured approach has been adopted. The components of the approach comprise, Toolkits, which provide step by step instruction for undertaking analysis tasks, Pro-forma's, which are used to collect the data required for the Workshops. Workshops serve to main purposes, first they enable the generation of non-algorithmic solutions and secondly by allowing those affected to fully participate in the appraisal process, improve ownership and commitment to the investment adopted.

The methodology begins by constructing a detailed manufacturing, profit and loss account for the Company. This acts both as an essential first step in calculating the cost of 'doing nothing' - the possible result if the Company does not invest, and as a 'base line' from which future benefits and costs of an investment can be fully appreciated.

Next, the process by which business needs can be determined using a combination of scenario generation and "what if" techniques is described. Having established the business needs the PROFIT CBT links "needs" to any one or a combination of eighty is possible manufacturing tools, techniques and technologies currently contained in the CBT's database. Using a simple yes/no questionnaire the PROFIT CBT recommends an appropriate investment by first questioning product design, process design, production and materials management before considering management and support activities. The nature of the 'company wide' benefits associated with each tool, technology and

technique are identified by the CBT and can be used as a guide from which the benefits of an investment in a particular situation can be made.

The PROFIT CBT expresses the 'company wide' benefits of new investment in terms of the Gross Profit, Net Profit, Gross Return On Sales and the Net Return On Sales. It can also display the projected Profit and Loss accounts of a business for the short, medium and long term for the best, worst and expected scenarios.

For those companies who require traditional financial justification criteria to be available, PROFIT can calculate the Return On Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), Break Even Analysis, both in terms of the number of units and monetary values, and Payback Period.

The paper concludes with a discussion of the results of tests undertaken in two large and four small companies.

## Appendix III Test Cases

### Evaluation of two test cases utilising the PROFIT Methodology Workbook

## **Company A Profile**

### **Introduction**

Company A is a wholly owned subsidiary and manufactures fluid dispensing equipment. The company employs a staff of 65 and has a turnover of £2.1m. Current profits are approximately £300,000.

The Company currently uses the Payback Period with the 'hurdle rate' set at 3 years.

### **Investment Case Study**

#### **Business Need**

Company A had recently been allowed by its parent Company to sell its products to other non-group companies. This facility was extremely attractive as the parent Company restricted Company A to supply its equipment at cost plus 10%, whereas the Company could secure a considerably higher price on the open market.

The case study for Company A, subsequently revolved around the potential increase in sales that would be possible in the new open market. In order to meet the expected demand Company A had recognised that it needed to increase its capacity.

## **Generating the Financial Model of the Current Business.**

**Deliverable 3 Sales Product Data.** Eleven sales product families were identified. However, as PROFIT currently can only consider a maximum of six or five and the rest totalled under "Other", Company A decided to consider the four main sales products and group the remainder under other. Sales product names were omitted to prevent identification of Company A's products by competitors. The products in the analysis are, therefore, only referred to as SP1, SP2, SP3, SP4 and "Others".

**Deliverable 4 - Production, Profit and Loss Account.** In order to complete Deliverable 4 (figure 53), data was collected via Pro-formas and entered onto the Deliverable 4 sub-factor sheets, as shown by figures 45 to 52.

In figure 45, Sales Revenue, the calculation of the "Other" sales revenue required summing the sales revenue for the seven sales products involved and then dividing the value by the volume of products sold to identify the average unit price.

In figure 46, Raw Material Costs, the Opening Stock and Closing Stock were based on the average stock held. Purchases were calculated by summing the total cost of raw materials used. The Company had little difficulty in identifying the raw material costs involved in production for each of the sales products. Again, the cost for the 'Others' was calculated by summing the material costs for the seven products and then dividing by the total volume produced to find the average cost. The percentage scrap rate was considered to be virtually consistent for all sales products.

Figure 47, Bought Out Part Costs were entered on the same basis as figure 45, except there was insignificant scrap.

Work In Progress (WIP) was based on 15% of average monthly raw material and bought out part purchases. WIP scrap was 3%. Figure 48.

Figure 49, Production Overheads. Labour costs were calculated on standard hours or minutes and, consequently, it was not possible to specify the costs associated with each Sales Product. Also, General Overheads were not normally apportioned to sales products. As a result, the method adopted by the PROFIT methodology to apportion Production Overheads based on Sales Revenue was used.

In Finished Goods Inventory (figure 50), because all orders are make to order, Opening and Closing stock of Finished Goods is zero.

Figure 51, Inventory Holding Costs are based on the data entered in figures 46, 47 and 48. The interest rate was based on the current rate at the time within the Group.

Figure 52, Expenses were calculated by summing approximate wages of staff not in production. The cost of inventory was the Inventory Holding Costs (figure 51). General Expenses covered the remaining costs.

**Deliverable 5 - Production, Profit and Loss Account.** Deliverable 5 covers the future financial scenarios, if the company continues as it is, for the expected, optimistic and pessimistic outcomes. In the case of Company A, the analysis was limited to only the expected outcome for years one and two. This provided sufficient data to show that without new investment to increase their capacity, their competitive advantage would be seriously eroded.

Figure 54 shows the possible future impact in full Production, Profit and Loss Account format, if the Company continues without investment for the expected scenario.

**Deliverable 6 - Expected Future Scenarios.** Figure 55, shows for comparison, the effect of continuing without investment as it pertains to the Net profit for the two years as analysed in Deliverable 5.

The results of Deliverable 6 when compared with Deliverable 4, show that from a current ROS of 14.3%, the 'Cost of Doing Nothing', will be a drop in ROS in the first year to 12% and in the second year a further drop in ROS to 5.8%. This situation results from the fact that in both years sales volume to outside buyers decreases as sales within the group increase and absorb part of the external sales. The unit price is limited within the group to 10% above cost and as the majority of sales are increasingly within the group, the sales revenue rises by only 2%. The situation is further exasperated by a rise of approximately 2.5% in cost of sales and a 6.5% increase in expenses.

**Deliverable 7 - Business Needs.** The Company knew it needed to improve capacity and, therefore, opted to undertake Evaluation Option Two - Identify an Investment. However, the selection of option two still requires specifying a business need as defined by the PROFIT Methodology. The business need selected was Increase Capacity.

**Deliverable 8 - Potential for Change.** The potential for change concentrated on Sales Products as opposed to a 'company wide' approach. This was due to the expected increase in the market for their sales products SP1 and SP2.

The product design of any of their sales products and the processes employed in production could not be changed without extensive re-tooling. They had recently



negotiated a new contract with their raw material suppliers and were, therefore, unwilling to consider changes in materials management. However, Production could change for both SP1 and SP2.

**Deliverable 9 - Agreed Investment.** Using Toolkit 3.2.3, Rule 31 was identified as being appropriate. From the list of possible investments that could be considered, Company A selected Additional Manufacturing Machine and Flexible Manufacturing System. The investments offered under Assembly and Inspection and Test were considered inappropriate. The full list of investments offered under Rule 31 were:

IF Business Need = Improve Capacity  
AND IF Sales Product PRODUCTION can change  
THEN the following Investments exist:  
    Additional Machine (Assembly and or Manufacturing)  
    Machining:  
        Flexible Manufacturing System  
        CNC  
        DNC  
        Turning/Machining Centres  
        Minimise Set-Up Times  
    Assembly:  
        Flexible Assembly System  
        Robots  
    Inspection and Test:  
        Operator Inspection Scheme  
        Automatic Test Equipment.

Having selected two possible investments, the next step required developing Investment Tracks. Both investments were discussed in relation to their individual impact on one or more sales products, as well as, in terms of amalgamating them into one overall investment. It was decided to proceed with both investments to the second step - Challenge Investment Tracks.

Challenge Investment Tracks is the process of rigorously assessing individual investments and investment tracks to eliminate conflicts and ensure that investments are effective and feasible. After much discussion it was agreed that

the investment in a Flexible Manufacturing System would increase duplication of manufacturing processes far in excess of the business requirements in the foreseeable future. The Duplicate Manufacturing Machine was, therefore, entered onto Deliverable 9 - Agreed Investment, for further consideration.

**Deliverable 10 - List of Benefits.** To identify possible benefits Toolkit 3.2.4 was used. Because the agreed investment was for a duplicate machine, the benefits offered by the PROFIT Methodology were limited, as it is impossible to know the benefits associated with an investment that could be virtually anything. However, the following list of benefits from the PROFIT Methodology were entered onto Deliverable 10:

- Increase capacity by known amount.
- Increase throughput.
- Reduce set up time
- Minimise disruption.
- Increase sales resulting from increased ability to meet sudden changes in demand and/or large orders.
- Increase sales revenue through increased unit price.

Deliverable 10 and Pro-forma 13 were then sent out to those areas affected by the benefits for the calculation of the value of the benefits.

**Deliverable 11 List of Costs.** The List of Costs were agreed as:

- Cost of the additional machine
- Disruption to the business during installation
- Waste produced during Set-Up.
- Additional shop-floor personnel
- Increased overtime.
- Increased Production Overheads.

Pro-forma 14 was sent out with Deliverable 11 to assist in the calculation of costs associated with the investment. To guide the users with the identification of costs of the investment Toolkit 4 was used.

**Deliverable 13 Benefits - Sales Revenue.** The effect of improved capacity for the first year is reflected in the increase in Sales Revenue for SP1 and SP2. SP1 has increased volume of sales from 75,000 to 90,000 and SP2 from 50,000 to 55,000. However, as the increase in Sales Revenue is generated as a result of a change in volume, the cost factors involved in producing the product will also increase, thereby, reducing the value in terms of net profit of the increased sales revenue. The increase in unit price was thought likely to be 20%, but only on the increased capacity. In the second year sales volume was expected to increase from 90,000 to 108,000 for SP1 and from 55,000 to 61,500 for SP2. In the third year SP1 would rise to 130,000 and SP2 to 67,500. In addition, in the first year it is anticipated that the increase in volume of goods produced will result in savings of 5% on raw materials and bought out parts for SP1 and SP2.

**Deliverable 14 Costs - Raw Materials and Bought Out Parts.** The cost of raw materials and bought out parts used in production, increase in proportion to the increase in volume.

**Deliverable 14 Costs - Production Overheads.** Production overheads were based on a rise in direct proportion to the increase in volume. Depreciation of the machine was calculated as £19,300 per year, based on the three year payback period used by the Company.

**Deliverable 14 Costs - Expenses.** Loan interest was based on the standard rate charged within the Group, at the time this was 10%. This gave interest charges of £5.7, £3.8 and £1.9 for years one, two and three respectively.

**Deliverable 15 - Production, Profit and Loss Account.** This was prepared for each year over a three year period, to cover the three year payback period used by the Company. The total figures, for each year, are shown on Deliverable 16, figure 56.

**Deliverable 16 - Expected Future Scenario with Investment.** Only the expected future scenario was used to compare the yearly effect of the investment on the business. Optimistic and pessimistic scenarios were not produced as the effect without the investment, Deliverable 6, concentrated only on the expected outcome. With the investment Company A could be compared to their current Net Profits expect to see an increase in Net Profits of £100,000 in the first year, £300,000 in the second and £600,000 in the third year.

**Deliverable 17 - Traditional Cost Justifications.** Traditional techniques provided a useful comparison. The investment would have been accepted by the Company without the PROFIT Methodology because it met the Payback Period criteria.

**Deliverable 18 - Accept or Reject Investment.** The investment was accepted.

## **Conclusion**

The PROFIT Methodology was applied successfully at Company A. The use of Pro-formas was found to be helpful in collecting the data in the necessary format and eased the completion of the Deliverables. As investment decisions are seldom algorithmic, the concept of Workshops encouraged the commitment to the overall process and the generation of suggestions.

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Sales Revenue</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Revenue</b>								
Sales Volume		75000	50000	50000	35000		140000	
Average Unit Price		7.56	10.34	3.00	8.32		4.15	
<b>Total Revenue / Product</b>		567000	517000	150000	291200	0	581000	2106200

Figure 45. Deliverable 4 - Sales Revenue

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Raw Material Costs</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Raw Materials</b>								
Opening Stock								130000
Purchases								447226
Closing Stock								130000
<b>Cost of Raw Materials Stock</b>								447226
<b>Volume of Goods Produced</b>								
Volume Produced		75000	50000	50000	35000	0	140000	
<b>Raw Material Cost of Goods Produced</b>								
Cost per unit		1.15	1.71	0.65	1.77	0.00	1.20	
Percentage Scrap per		3.00	3.00	3.00	3.00	0.00	3.00	
<b>Total Cost of Raw Mats.</b>		88838	88065	33475	63809	0	173040	447226

Figure 46 Deliverable 4 - Raw Material Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Bought Out Parts Costs</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Bought Out Parts</b>								
Opening Stock								20000
Purchases								74650
Closing Stock								20000
<b>Cost of B.O.P. Stock</b>								74650
<b>Volume of Goods Produced</b>								
Volume Produced		75000	50000	50000	35000	0	140000	
<b>Total Cost of Bought Out Parts</b>								
Cost per unit		0.19	0.30	0.11	0.30	0.00	0.21	
Percentage Scrap per unit		0.00	0.00	0.00	0.00	0.00	0.00	
<b>Total Cost of Bought Out Parts</b>		14250	15000	5500	10500	0	29400	74650

Figure 47 Deliverable 4 - Bought Out Part Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Work In Progress Costs</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Work In Progress</b>								
Opening Stock								6500
Closing Stock								6500
Change In W.I.P								0
<b>% Scrap</b>								3.00
<b>Total W.I.P Used</b>								195
<b>Apportioned W.I.P Costs</b>		52.50	47.87	13.89	26.96	0.00	53.79	195.00
<b>Entered W.I.P Costs</b>								

Figure 48 Deliverable 4 - Work In Progress



<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Production Overheads</b>						
		PF1	PF2	PF3	PF4	Others	Total	
<b>Production Overheads</b>								
Wages and Salaries							390000	
Rates								
Depreciation (Building)								
Depreciation (Plant)								
Maintenance								
General Overheads							415000	
<b>Total Production O/Hs</b>							805000	
<b>Apportioned Prod. O/Hs</b>		216710	197600	57331	111298	0	222061	805000
<b>Entered Production O/Hs</b>								

Figure 49 Deliverable 4 - Production Overheads

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Finished Goods Inventory</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Finished Goods Volume</b>								
Opening Stock		0	0	0	0		0	
Plus Fin. Goods Produced		75000	50000	50000	35000	0	140000	
Total		75000	50000	50000	35000	0	140000	
Less Fin. Goods Sold		75000	50000	50000	35000	0	140000	
Less Fin. Goods Scrapped		0	0	0	0	0	0	
Closing Stock		0	0	0	0	0	0	
<b>Cost of Finished Goods Inventory</b>								
Cost of Opening Stock		0	0	0	0		0	0
Cost of Goods Produced		319850	300713	96320	185634	0	424555	1327071
Total		319850	300713	96320	185634		424555	1327071
Less Fin. Goods Sold		319850	300713	96320	185634	0	424555	1327071
Less Cost of Scrap		0	0	0	0		0	0
Cost of Closing Stock		0	0	0	0		0	0

Figure 50 Deliverable 4 - Finished Goods Inventory

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Inventory Holding Costs</b>					
	PF1	PF2	PF3	PF4		Others	Total
<b>Capital Invested In Inventory</b>							
Average Raw Material							130000
Average Bought Out Parts							20000
Average WIP							6500
Average Finished Goods	0	0	0	0		0	0
<b>Total Capital Invested</b>							<b>156500</b>
<b>Interest Rate</b>							
Interest Rate							10.00
Cost of Capital In							15650
<b>Fin. Goods Scrapped</b>							
Fin. Goods Scrapped	0.00	0.00	0.00	0.00		0.00	0.00
<b>Total Inventory Holding Costs</b>							
<b>Total Inventory Holding Costs</b>							<b>15650</b>

Figure 51 Deliverable 4 - Inventory Holding Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Expenses</b>						
		PF1	PF2	PF3	PF4		Others	Total
<b>Expenses</b>								
Salaries								210000
Loan Interest								
Depreciation (Building)								
Depreciation (Equipment)								
Cost of Inventory								15650
General Expenses								254000
<b>Total Expenses</b>								<b>479650</b>

Figure 52 Deliverable 4 - Expenses

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Production, Profit &amp; Loss Account</b>					
	PF1	PF2	PF3	PF4		Others	Total
<b>Revenue</b>							
Sales	567000	517000	150000	291200	0	581000	2106200
<b>Production Account</b>							
Raw Material	88838	88065	33475	63809	0	173040	447226
Bought Out Parts	14250	15000	5500	10500	0	29400	74650
W.I.P.	52	48	14	27	0	54	195
Production Costs	216710	197600	57331	111298	0	222061	805000
<b>Cost of Goods Produced</b>	319850	300713	96320	185634	0	424555	1327071
<b>Cost of Fin. Goods Sold</b>	319850	300713	96320	185634	0	424555	1327071
<b>Gross Profit</b>	247150	216287	53680	105566	0	156445	779129
<b>Gross R.O.S. %</b>	43.6%	41.8%	35.8%	36.3%	0.0%	26.9%	37.0%
<b>Total Expenses</b>							479650
<b>Net Profit</b>							299479
<b>R.O.S. %</b>							14.2%

Figure 53 Deliverable 4 - Current Production, Profit and Loss Account

<b>PROFIT by P. Larsen</b>		<b>Deliverable 5 - Production, Profit &amp; Loss Account</b>					
<b>YR 1 EXPECTED</b>	PF1	PF2	PF3	PF4		Others	Total
<b>Revenue</b>							
Sales	577500	527500	153000	297150	0	592200	2147350
<b>Production Account</b>							
Raw Material	92700	92185	35535	67053	0	181692	469165
Bought Out Parts	15000	16000	6500	11200	0	32200	80900
W.I.P.	55	50	15	28	0	57	205
Production Costs	221940	202724	58800	114198	0	227589	825251
<b>Cost of Goods Produced</b>	329695	310959	100850	192479	0	441538	1375521
<b>Cost of Fin. Goods Sold</b>	329695	310959	100850	192479	0	441538	1375521
<b>Gross Profit</b>	247805	216541	52150	104671	0	150662	771829
<b>Gross R.O.S. %</b>	42.9%	41.1%	34.1%	35.2%	0.0%	25.4%	35.9%
<b>Total Expenses</b>							513435
<b>Net Profit</b>							258394
<b>R.O.S. %</b>							12.0%

Figure 54 Deliverable 5 - Expected Production, Profit and Loss Account

<b>PROFIT by P. Larsen</b>		<b>Deliverable 6 EXPECTED Future no Investment</b>				
		<b>YEAR 1</b>	<b>YEAR 2</b>	<b>YEAR 3</b>	<b>YEAR 4</b>	<b>YEAR 5</b>
<b>Revenue</b>						
Sales		2147350	2137750			
<b>Production Account</b>						
Raw Material		469165	486830			
Bought Out Parts		80900	90300			
W.I.P.		206	216			
Production Costs		825250	885000			
<b>Cost of Goods Produced</b>		1375521	1462346			
<b>Cost of Fin. Goods Sold</b>		1375521	1462346			
<b>Gross Profit</b>		771830	675404			
<b>Gross R.O.S. %</b>		35.9%	31.6%			
<b>Total Expenses</b>		513435	550553			
<b>Net Profit</b>		258394	124851			
<b>R.O.S. %</b>		12.0%	5.8%			

Figure 55 Deliverable 6 - Expected Scenario without Investment

<b>PROFIT by P. Larsen</b>		<b>Deliverable 16 EXPECTED Future with Investment</b>				
		<b>YEAR 1</b>	<b>YEAR 2</b>	<b>YEAR 3</b>	<b>YEAR 4</b>	<b>YEAR 5</b>
<b>Revenue</b>						
Sales		2390600	2785495	3187158		
<b>Production Account</b>						
Raw Material		463706	532855	547328		
Bought Out Parts		85500	99740	104694		
W.I.P.		207	231	255		
Production Costs		928300	963300	1026300		
<b>Cost of Goods Produced</b>		1477713	1596126	1678577		
<b>Cost of Fin. Goods Sold</b>		1477713	1596126	1678577		
<b>Gross Profit</b>		912887	1189369	1508581		
<b>Gross R.O.S. %</b>		38.2%	42.7%	47.3%		
<b>Total Expenses</b>		518240	553822	577062		
<b>Net Profit</b>		394647	635547	931519		
<b>R.O.S. %</b>		16.5%	22.8%	29.2%		

Figure 56 Deliverable 16 - Expected Future Scenario with Investment



## **Company B**

### **Introduction**

Company B manufactures scientific instruments and employs a staff of twenty-seven. From market research undertaken by the Company, it was believed that profitability could be increased by a combination of cost reduction and improved customer service.

Discussions with the Company about its products, markets and marketing strategy revealed that:

- Customers usually have a fixed amount to spend.
- The products are built from modules which are configured to customer requirements.
- Orders are secured by meeting customer specification or by offering more modules (better value for money).

In effect this means that the Company's products are sold on price, as the reduction of costs allows the customer to obtain more for their planned spend.

### **Generating the Financial Model of the Current Business.**

**Deliverable 3 Sales Product Data.** Company B had two sales product families , referred to in this test as SP1 and SP2, that currently made a significant contribution to the profitability of the company. Consequently, analysis concentrated on these two sales product families.

**Deliverable 4 - Production, Profit and Loss Account.** In order to complete Deliverable 4 (figure 65), data was collected via Pro-formas and entered onto the Deliverable 4 sub-factor sheets, as shown by figures 57 to 64.

Figure 57 shows that the volumes produced by the Company are very low, SP1 produced in tens and SP2 in single figures.

In figure 58 and 59, Raw Material Costs and Bought Out Part Costs respectively. The Opening Stock and Closing Stock were based on the average stock held. Purchases were calculated by summing the total cost of the raw materials and bought out parts used as appropriate. The Company had little difficulty in identifying the material costs involved in production for each of the sales products. The raw material percentage scrap rate was known to be slightly higher for SP1. Bought out parts scrap was consistent for both sales product families.

Figure 60, Work In Progress (WIP) was relatively high compared to the value of both raw material and bought out parts stocks. This was due mainly to the long lead time involved in the production of the SP1 and SP2. Lead time was currently running at 6 to 7 months. Even under favourable circumstances, where a customer required a product urgently, it was thought highly unlikely that a product could be delivered in under 3 months. WIP scrap was 2%.

Figure 61, Production Overheads. Labour costs were calculated on standard hours or minutes and, consequently, it was not possible to specify the costs associated with each Sales Product. Also, General Overheads were not normally apportioned to sales products. As a result, the method adopted by the PROFIT methodology to apportion Production Overheads based on Sales Revenue was used.

In Finished Goods Inventory (figure 62), because all orders are 'make to order', Opening and Closing stock of Finished Goods is zero.

Figure 63, Inventory Holding Costs are based on the data entered in figures 58, 59 and 60. The interest rate was based on the current rate used by the Company.

Figure 64, Expenses were stated as approximately £182,000. The cost of inventory was the Inventory Holding Costs (figure 63).

Figure 65 displays the current Production , Profit and Loss Account for SP1 and SP2.

**Deliverable 6 - Expected Future Scenarios.** Figure 66, shows for comparison, the effect of continuing without investment as it pertains to the Net profit for the two years analysed.

The results of Deliverable 6 when compared with Deliverable 4, show that from a current ROS of 27.8%, the 'Cost of Doing Nothing', will be a steady decline in ROS of approximately 4% each year. This situation results from the fact that in order to increase sales volume it is seen as vital to reduce costs. Without such a reduction it is expected that sales will remain constant. Due to the competition it is not feasible to increase the unit prices.

**Deliverable 7 - Business Needs.** The Company knew from its market research that a reduction of 20% in product costs for SP1 would generate at least six new orders each year, over the next two years. However, to gain the most benefit from the PROFIT process, Company B opted to undertake Evaluation Option One - Identify Business Needs before progressing to identifying possible investments.

Option One requires a company to rotate the sales revenue and cost factors of the Profit and Loss Account to view the effects changes to these factors can have on the ROS and Net Profits of the Company. In figure 67 - Toolkit 3.1, Option 1, the effect of rotating the variables can be seen. Company B by reducing bought out part costs by 10%, thought an increase in sales volume of 20% for SP1 would be possible. However, the increase in sales revenue resulting from an increase of 20% in sales volume for SP1, also resulted in a proportionate increase in raw material costs, bought out part costs and production overheads for SP1, therefore the increase in ROS for SP1 only rises from its current value of 35.7% to 38.6%.

Using the Identify Business Needs Mechanisms, Company B identified possible Business Needs. They were:

From figure 27:

Increase Net Profit by reducing Unit Price and increasing volume sold =

Reduce Costs

Reduce Lead Time

Improve Delivery Performance

Improve Functionality and Features

Improve Product Quality

Increase Capacity.

From figure 31:

Increase Net Profit by reducing Raw Material costs and maintain Bought

Out Part costs or visa versa, reduce WIP and increase Production

Overheads =

Reduce Costs

Reduce Lead Time

Improve Delivery Performance

Improve Product Quality

From figure 32:

Increase Net Profit, reduce Raw Material and Bought Out Part costs,  
reduce WIP and increase Production Overheads =

Reduce Costs

Reduce Lead Time

Improve Product Quality

Company B, from its market research, had identified that its products were sold on price, long lead times common to the industry, and, therefore, discarded Reduce Lead Time and Improve Delivery Performance. Quality, although important to the Company in selling its products, was considered by management to be above the industry average and not readily suitable for further improvement, as a result the Business Need 'Improve Product Quality' was rejected. As the Company knew it had spare capacity, the Business Need Increase Capacity was also discarded. Improving the functionality and or features of its products was a major factor in selling Company B's products. However, the functions and features comprising the specification of any product was highly dependent on cost and, consequently, Company B chose not to consider the Business Need 'Improve Functionality and Features'.

This left Company B with the following Business Needs to consider:

Reduce Costs

Improve Customer Services

**Deliverable 8 - Potential for Change.** The potential for change concentrated on Sales Products as opposed to a 'Company Wide' approach. This was due to the expected increase in sale volumes of SP1.

Looking at Company B's business processes revealed that on a Sales Product basis Materials Management and Support Processes could change.

**Deliverable 9 - Agreed Investment.** Using Toolkit 3.2.3, Rules 4, 5, 25 and 26 were identified as being appropriate. From the list of possible investments that could be considered, Company B selected Re-negotiate Supplier Contracts and Hotline Support Training. The full list of investments offered under the Rules were:

**RULE 4.**

**IF Business Need = Reduce Costs**

**AND IF Sales Product MATERIALS MANAGEMENT can change**

**THEN the following Investments exist:**

**Raw Materials and Bought Out Parts:**

Vendor Rating Management

Open Orders

**Supplier Contract Re-negotiation**

Reduce Scrap

Electronic Data Interchange (EDI)

Procurement Engineering (Parts Only)

**Inventory Management:**

Automatic Warehousing, Storage and Retrieval System

**RULE 5.**

**IF Business Need = Reduce Costs**

**AND IF Sales Product SUPPORT can change**

**THEN the following Investments exist:**

**Facilities:**

Sales Order Processing

Change Packing

Automatic Packaging

**Re-negotiate Supplier and or Delivery Contracts**

**RULE 25.**

**IF Business Need = Improve Customer Service**

**AND IF Sales Product MATERIALS MANAGEMENT can change**

**THEN the following Investments exist:**

**Inventory:**

Inventory management

JIT

Kanban

**RULE 26.**

**IF Business Need = Improve Customer Service  
AND IF Sales Product SUPPORT can change  
THEN the following Investments exist:**

**Local Distribution:**

**Training**

**After Sales Service:**

**On-Site Support Training**

**Hotline Support Training**

**Installation and commissioning Training**

**Warranty and Guarantee**

Having selected two possible investments, the next step required developing an Investment Track. The investments were first discussed individually in relation to their impact on one or both sales products and then as an investment programme.

As some of SP1's bought out parts were common to SP2, SP2's product costs would also be reduced by only re-negotiating SP1's supplier contract. However, it was decided to undertake the investment analysis on a wider sphere by considering the effect that re-negotiating supplier contracts could have on both SP1 and SP2, for both bought out parts and raw materials.

Sales order processing raised the point that much time was wasted chasing orders from suppliers and if the Company could re-negotiate the supplier contracts then this could reduce the Administration costs.

Before continuing to the next stage Company B decided to view the effect on the Production, Profit and Loss Account of reducing bought out parts and raw materials for both sales product families. This would also provide the chance to consider savings in Administration costs.

Figure 68 Toolkit 3.1 Option 2 shows the effect of reducing raw material costs and bought out part costs for SP1 and SP2 by 10%, and reducing expenses by

£9000. These actions resulted in a Gross ROS of 40.1% for SP1 and 41.1% for SP2, with the ROS for the whole company at 31.9%.

Returning to the Identify Business Needs Mechanisms, from figure 36, to increase the Net Profit by reducing Salaries, increasing Inventory Holding Costs and reducing General Expenses, Company B identified Reduce Costs and Improve Customer Service as potential investments. Company B then proceeded to repeat the steps of Identify Investment Tracks and Challenge Investment Tracks.

The final decision, for Company B, was to proceed with Re-negotiate Supplier Contracts and Improve Customer Services by instigating a 'Hotline' Support Training programme.

**Deliverable 10 - List of Benefits.** To identify possible benefits Toolkit 3.2.4 was used. Benefits identified for Rule 5 and 26 were entered onto Deliverable 10:

**General Benefit**

- Increased Sales Volume

**Re-negotiate Supplier/Delivery Contracts**

- Reduce purchase price.
- Increase time period or amount of credit facility.
- Reduce/increase economic order quantity.
- Reduce/increase part/material order quality.
- Reduce inventory levels.
- Reduce inventory space.

**Hotline Support Training**

- Real time advice on installation, application operation and maintenance problems.
- Help line to assist urgent customer problems.
- Improved customer satisfaction knowing help is at hand.

Deliverable 10 and Pro-forma 13 were then sent out to those areas affected by the benefits for the calculation of the value of the benefits.



**Deliverable 11 List of Costs.** The List of Costs were agreed as:

- Cost of Re-negotiating Supplier Contracts for raw materials and bought out parts for SP1 and SP2.
- Training course for After Sales Service Staff.
- Increased Production Costs.
- Increased WIP.
- Increased cost of Inventory.

Pro-forma 14 was sent out with Deliverable 11 to assist in the calculation of costs associated with the investments. To guide the users with the identification of costs of the investment Toolkit 4 was used.

**Deliverable 13 Benefits - Sales Revenue.** Sales of SP1 were expected to increase at the rate of 20% per year, especially as 'Hotline' Support could be offered as 'standard' and not as an 'extra'. SP2 was expected to maintain a flat demand.

**Deliverable 13 Benefits - Raw Materials and Bought Out Parts.** Raw materials for SP1 were not expected to offer any significant savings. However, SP2 could provide a 15% reduction. Bought out parts for both Sales Product Families provided an expected saving of 12.5%

**Deliverable 13 Benefits - Work In Progress (WIP).** 12.5% savings applied to 75% of total WIP.

**Deliverable 13 Benefits - Expenses.** Savings from reducing time spent chasing orders and from reduced Administration costs were anticipated to be around £9000.

**Deliverable 14 Costs - Production Overheads.** Production overheads were based on a rise in direct proportion to the increase in volume of SP1s produced.

**Deliverable 14 Costs - Expenses.** The costs for re-negotiating the contract amounted to £3000 and the training and the increase in general expenses were calculated at £5000. The total £8000 was added to Expense costs as a 'one off' payment.

**Deliverable 16 - Expected Future Scenario with Investment.** (Figure 69.) Only the expected future scenario was used to compare the yearly effect of the investment on the business. Optimistic and pessimistic scenarios were not produced as the effect without the investment, Deliverable 6, concentrated only on the expected outcome. With the investment, Company B could, compared to their expected future scenario without any investment, expect to see an increase in Net Profits of 50% in the first year and over 100% increase in the second.

**Deliverable 17 - Traditional Cost Justifications.** The Payback Period as traditionally used by the Company provided a useful comparison. However, it could not show the full benefits and improvement in profitability of the investment programme after the investment had been paid for.

**Deliverable 18 - Accept or Reject Investment.** The investment was accepted.

## **Conclusion.**

The analysis using PROFIT concentrated only on the two main sales product families, all the other products manufactured and or assembled by Company B were exempt from the analysis. This provided the opportunity to test PROFIT in a new situation - on part of a company's operations, because although the other products produced by the company did not currently add significantly to the profitability, they would have added to the costs.

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Sales Revenue</b>					
		PF1	PF2			Others	Total
<b>Revenue</b>							
Sales Volume		30	2	0	0	0	
Average Unit Price		40000	450000	0	0	0	
<b>Total Revenue / Product</b>		1200000	900000	0	0	0	2100000

Figure 57 Deliverable 4 - Sales Revenue

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Raw Material Costs</b>					
		PF1	PF2				Total
<b>Raw Materials</b>							
Opening Stock							12500
Purchases							277236
Closing Stock							12500
<b>Cost of Raw Materials Stock</b>							277236
<b>Volume of Goods Produced</b>							
Volume Produced		30	2	0	0	0	0
<b>Raw Material Cost of Goods Produced</b>							
Cost per unit		5600	49765	0	0	0	0
Percentage Scrap per		4.00	3.00	0.00	0.00	0.00	0.00
<b>Total Cost of Raw Mats.</b>		174720	102516	0	0	0	277236

Figure 58 Deliverable 4 - Raw Material Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Bought Out Parts Costs</b>					
	PF1	PF2					Total
<b>Bought Out Parts</b>							
Opening Stock							40000
Purchases							822120
Closing Stock							40000
<b>Cost of B.O.P. Stock</b>							822120
<b>Volume of Goods Produced</b>							
Volume Produced	30	2	0	0	0	0	
<b>Total Cost of Bought Out Parts</b>							
Cost per unit	15300	173500	0	0	0	0	
Percentage Scrap per unit	2.00	2.00	0.00	0.00	0.00	0.00	
<b>Total Cost of Bought Out Parts</b>	468180	353940	0	0	0	0	822120

Figure 59 Deliverable 4 - Bought Out Part Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Work In Progress Costs</b>					
		PF1	PF2				Total
<b>Work In Progress</b>							
Opening Stock							40625
Closing Stock							40625
Change In W.I.P							0
<b>% Scrap</b>							
							2.00
<b>Total W.I.P Used</b>							813
<b>Apportioned W.I.P Costs</b>							
		464	348	0	0	0	813
<b>Entered W.I.P Costs</b>							

Figure 60 Deliverable 4 - Work In Progress

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Production Overheads</b>					
		PF1	PF2				Total
<b>Production Overheads</b>							
Wages and Salaries							150000
Rates							
Depreciation (Building)							
Depreciation (Plant)							
Maintenance							
General Overheads							75000
<b>Total Production O/Hs</b>							225000
<b>Apporioned Prod. O/Hs</b>		128571	96429	0	0	0	0
<b>Entered Production O/Hs</b>							

Figure 61 Deliverable 4 - Production Overheads

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Finished Goods Inventory</b>						
	PF1	PF2					Total	
<b>Finished Goods Volume</b>								
Opening Stock	0	0	0	0			0	
Plus Fin. Goods Produced	30	2	0	0	0	0		
Total	30	2	0	0	0	0		
Less Fin. Goods Sold	30	2	0	0	0	0		
Less Fin. Goods Scrapped	0	0	0	0	0	0		
Closing Stock	0	0	0	0	0	0		
<b>Cost of Finished Goods Inventory</b>								
Cost of Opening Stock	0	0	0	0			0	
Cost of Goods Produced	771936	553233	0	0	0	0	1325168	
Total	771936	553233	0	0			1325168	
Less Fin. Goods Sold	771936	553233	0	0	0	0	1325168	
Less Cost of Scrap	0	0	0	0			0	
Cost of Closing Stock	0	0	0	0			0	

Figure 62 Deliverable 4 - Finished Goods Inventory



<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Inventory Holding Costs</b>						
	PF1	PF2					Total	
<b>Capital Invested in Inventory</b>								
Average Raw Material							12500	
Average Bought Out Parts							40000	
Average WIP							40625	
Average Finished Goods	0	0	0	0		0	0	
<b>Total Capital Invested</b>							93125	
Interest Rate							10.00	
Cost of Capital in							9313	
Fin. Goods Scrapped	0.00	0.00	0.00	0.00		0.00	0.00	
<b>Total Inventory Holding Costs</b>							9313	

Figure 63 Deliverable 4 - Inventory Holding Costs

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Expenses</b>					
		PF1	PF2				Total
<b>Expenses</b>							
Salaries							112000
Loan Interest							0
Depreciation (Building)							
Depreciation (Equipment)							
Cost of Inventory							9313
General Expenses							70000
<b>Total Expenses</b>							<b>191313</b>

Figure 64 Deliverable 4 - Expenses

<b>PROFIT by P. Larsen</b>		<b>Deliverable 4 - Production, Profit &amp; Loss Account</b>					
	PF1	PF2					Total
<b>Revenue</b>							
Sales	1200000	900000	0	0	0	0	2100000
<b>Production Account</b>							
Raw Material	174720	102516	0	0	0	0	277236
Bought Out Parts	468180	353940	0	0	0	0	822120
W.I.P.	464	348	0	0	0	0	813
Production Costs	128571	96429	0	0	0	0	225000
<b>Cost of Goods Produced</b>	771936	553233	0	0	0	0	1325168
<b>Cost of Fin. Goods Sold</b>	771936	553233	0	0	0	0	1325168
<b>Gross Profit</b>	428064	346767	0	0	0	0	774832
<b>Gross R.O.S. %</b>	35.7%	38.5%	0.0%	0.0%	0.0%	0.0%	36.9%
<b>Total Expenses</b>							191313
<b>Net Profit</b>							583519
<b>R.O.S. %</b>							27.8%

Figure 65 Deliverable 4 - Current Production, Profit and Loss Account

<b>PROFIT by P. Larsen</b>		<b>Deliverable 6 EXPECTED Future Scenarios</b>				
		<b>YEAR 1</b>	<b>YEAR 2</b>	<b>YEAR 3</b>	<b>YEAR 4</b>	<b>YEAR 5</b>
<b>Revenue</b>						
Sales		2100000	2100000			
<b>Production Account</b>						
Raw Material		290161	304188			
Bought Out Parts		867510	897600			
W.I.P.		817	824			
Production Costs		243000	254900			
<b>Cost of Goods Produced</b>		1401488	1457512			
<b>Cost of Fin. Goods Sold</b>		1401488	1457512			
<b>Gross Profit</b>		698512	642488			
<b>Gross R.O.S. %</b>		33.3%	30.6%			
<b>Total Expenses</b>		208890	224895			
<b>Net Profit</b>		489622	417593			
<b>R.O.S. %</b>		23.3%	19.9%			

Figure 66 Deliverable 6 - Expected Scenario without Investment

<b>PROFIT by P. Larsen</b>		<b>Toolkit 3.1 - Rotating the Variables</b>					
<b>OPTION 1</b>	PF1	PF2					Total
<b>Revenue</b>							
Sales	1440000	900000					2340000
<b>Production Account</b>							
Raw Material	209664	107642					317306
Bought Out Parts	505634	371637					877271
W.I.P.	500	360					860
Production Costs	168000	98000					266000
<b>Cost of Goods Produced</b>	<b>883798</b>	<b>577639</b>					<b>1461437</b>
<b>Cost of Fin. Goods Sold</b>	<b>883798</b>	<b>577639</b>					<b>1461437</b>
<b>Gross Profit</b>	<b>556202</b>	<b>322361</b>					<b>878563</b>
<b>Gross R.O.S. %</b>	<b>38.6%</b>	<b>35.8%</b>					<b>37.5%</b>
<b>Total Expenses</b>							<b>208890</b>
<b>Net Profit</b>							<b>669673</b>
<b>R.O.S. %</b>							<b>28.6%</b>

**Help:**

Use this Production, Profit and Loss Account to calculate and or record changes to the Sales Revenue and Cost Factors when Rotating the Variables.

Figure 67 Toolkit 3.1 Rotating the Variables - Option 1

<b>PROFIT by P. Larsen</b>		<b>Toolkit 3.1 - Rotating the Variables</b>					
<b>OPTION 2</b>	PF1	PF2					Total
<b>Revenue</b>							
Sales	1440000	900000					2340000
<b>Production Account</b>							
Raw Material	188698	96878					285575
Bought Out Parts	505634	334473					840107
W.I.P.	500	324					824
Production Costs	168000	98000					266000
<b>Cost of Goods Produced</b>	862832	529675					1392507
<b>Cost of Fin. Goods Sold</b>	862832	529675					1392507
<b>Gross Profit</b>	577168	370325					947493
<b>Gross R.O.S. %</b>	40.1%	41.1%					40.5%
<b>Total Expenses</b>							199890
<b>Net Profit</b>							747603
<b>R.O.S. %</b>							31.9%

**Help:**

Use this Production, Profit and Loss Account to calculate and or record changes to the Sales Revenue and Cost Factors when Rotating the Variables.

Figure 68 Toolkit 3.1 Rotating the Variables - Option 2

<b>PROFIT by P. Larsen</b>		<b>Deliverable 16 EXPECTED Future with Investment</b>				
		<b>YEAR 1</b>	<b>YEAR 2</b>	<b>YEAR 3</b>	<b>YEAR 4</b>	<b>YEAR 5</b>
<b>Revenue</b>						
Sales		2340000	2620000			
<b>Production Account</b>						
Raw Material		325226	369671			
Bought Out Parts		801287	896873			
W.I.P.		737	773			
Production Costs		266467	297360			
<b>Cost of Goods Produced</b>		1393717	1564677			
<b>Cost of Fin. Goods Sold</b>		1393717	1564677			
<b>Gross Profit</b>		946283	1055323			
<b>Gross R.O.S. %</b>		40.4%	40.3%			
<b>Total Expenses</b>		207890	209685			
<b>Net Profit</b>		738393	845639			
<b>R.O.S. %</b>		31.6%	32.3%			

Figure 69 Deliverable 16 - Expected Future Scenario with Investment

