A PC-BASED ALTERNATIVES EVALUATION SOFTWARE FOR JUSTIFYING AUTOMATION AND NEW TECHNOLOGIES BASED ON STRATEGIC AND FINANCIAL METHODOLOGIES,

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Master of Science in Industrial and Systems Engineering

by
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Chapter 1
INTRODUCTION

In today's global manufacturing environment customers are demanding better quality products at reasonable prices, better services, and products that are delivered when required with minimal lead time. A long term strategic manufacturing plan will lead to manufacturing excellence and will improve the product cost, quality, service, and delivery. Such a plan will contribute to the overall business success and is the key to manufacturing competitiveness in today's global market.

Chapter One is an overall view of justification methodologies and approaches. It is divided into four sections: the first section briefly describes general justification approaches and methodologies, and the methods that are currently being used by American manufacturers; the second section describes and states the problems of justifying new technologies and automation; thirdly the author briefly states his general objective; finally, the author describes his overall approach to the development of an approach (software) to justifying automation and new technologies.

Management must and should have long term strategies which involve issues such as: technology advancement, plant modernization, competitive edge, sources of capital, and the introduction of new product lines. To implement these new strategies business and management will have to change their ways
of doing business. New management philosophies must be formulated to meet the challenges of remaining ahead of competitors with better quality products, better services, timely deliveries, lower costs, and flexible manufacturing facilities.

New technologies and automation provide powerful manufacturing techniques that will lead to excellence. However, managers have learned painful lessons regarding investment in the "alphabet soup" of modern manufacturing. First of all, the amount of capital required to invest and implement new technologies is immense. Second, successful implementation requires the total commitment of the top management of the organization as well as the acceptance of the organization's employees. And third, since the expenditure of funds and time are required, some means must be found financially and or otherwise to justify those expenditures to owners, stockholders or financiers.

In recent years the justification of new manufacturing technologies has received wide attention from journal articles, trade journals, books, papers, and so on. These publications suggested a variety of justification methodologies: from traditional engineering economy approaches (return on investment, present worth, annual worth, internal rate of return, cash flows, and so on), to purely quantitative scoring methods for ranking the alternatives. These methodologies are discussed in more detail in Chapter 2.

1.1 Background

Basically, there are three general approaches to investment justification. The first approach is strategic; that is, to argue the
importance of the new item to the long term strategy of the firm and to suggest that not to move forward will not be in the best interest of the firm and may lead to strategic suicide. A second approach is tactical based on economic performance. This involves identifying costs and benefits and summarizing the economic performance using engineering economy or other financial methodologies. The third approach is to simulate the system mathematically and then evaluate the resulting economic performance. This method is quite expensive and requires a very broad understanding of the system by its developer.

A recent survey (Bonsack 1988) of 1,000 major companies undertaking computer integrated manufacturing (CIM) projects indicated that 58 percent used the payback method, 39 percent used discounted cash flow, 32 percent used cost/benefit analysis, 10 percent used strategic arguments, and 10 percent used other methods. Since these add up to more than 100 percent it is clear that some companies used more than one methodology. It is also fair to state that this survey indicates that most companies used engineering economy approaches to justify the introduction of CIM and or other new technologies.

The acronym CIM will be loosely used throughout this thesis. The following definition of Computer-Integrated Manufacturing (CIM) will be used. Any computer oriented equipment or system which can achieve or aid in an automated manufacturing facility.

Manufacturing enterprises are perpetual entities which are regarded as continuous flow processes. Therefore any equipment or system that will increase integration, tying together adjacent operations with each other and with the overall control system will
be referred to as CIM. In other words, CIM is any automated equipment or system that contributes to the computer integration of the manufacturing facility.

Interestingly, most managers believe that traditional financial justification procedures that are based on internal rate of return, payback period, return on investment, and so on, are barriers to the utilization and justification of new technologies by U.S. manufacturing industries. Furthermore, most managers believe that new methodologies and strategies must be investigated and used. Yet by all accounts most surveys indicate that industries are still widely using these methodologies to justify new technologies even though the majority of them believe that these methodologies are inadequate and may hinder justification.

1.2 Statement of the Problem

Most manufacturing experts believe that U.S. industries must invest capital in plant and equipment if they plan to stay in business and be able to compete in today's and in future global markets. However, new technologies and automation cannot be justified for automation's and or expansion's sake. A clear long-term strategy must be planned to lay down the foundation for the acquisition of new equipment and technologies (CIM, CAD/CAM, AGVs, AS/RSs, and so on) that will enable U.S. industries to offer better quality products, better service, and flexible/adaptable manufacturing systems that will be competitive in the ever-changing global market. In the natural world, species that adapt to a changing environment will survive, and those species that don't will become
extinct like so many before them. The same fate awaits those manufacturing companies that will not change their ways and adapt to the ever-changing environment of the competitive global market.

Rapid market variability and technology changes can shorten product life cycles, causing capital equipment to become obsolete quickly. Coupled with the high cost of automation and new technologies, this may lead to the lack of investment in plant and equipment. Moreover, it's reasonable to assume that productivity will decline unless plants are modernized and equipment is kept up to date technically and operationally. This can lead to a decline in a firm's competitive position, which can be disastrous since its competitors are actively pursuing the same market with novel facilities and equipment.

Engineering economy approaches are tactical investment decisions that are mainly concerned with the short-term position of the firm in such areas as cost avoidance, reduction of inventories, reworks, and so on. Thus this tactical analysis is interested in the cost reduction aspects of the profit equation rather than the revenue creation (opportunities) facets of the equation.

Since most managers believe that traditional justification methodologies are not quite adequate for evaluating new technologies and that many/most U.S. plants need modernization and new equipment, why haven't changes been made? The remainder of this section will explore some of the reasons and issues concerning the introduction of new technologies and the reasons why such projects often fail.

Some managers believe that one reason is the lack of capital to invest in new equipment that can cost millions of dollars. Also
when coupled with shortened product life cycles, this costly capital equipment can become obsolete rather quickly. Then the question must be asked, where did the capital come from for the mergers and acquisition that have occurred in record numbers in the last few years. This does not explain the decline in capital spending. Corporate acquisitions are not a substitute for direct investment nor do they provide a cheap method or a bargain for acquiring equipment or plants. Most mergers involve acquisition prices that are above the market value because most often some premium is generally required to entice managers or stockholders to approve the sale. Therefore the market value is inflated.

Other managers blame the business itself for the problem, often where emphasis is placed on the short-term return on investment with high hurdle rates. This can be attributed to a number of causes: the way businesses reward managers by rapid advancement based on financial performance; the desire by young managers to advance, spending limited amount of time at different jobs along the way; and pressure from the financial community, stockholders and financiers who want quick returns on their investments. See Figure 1-1. The author tends to agree with some of these arguments, there is a need for managers and the business community to explore new horizons with longer periods of return on investments.

Other experts believe that the current accounting systems are inadequate for the information and automation age. Systems that are mainly designed to value inventory for financial and tax purposes do not give managers accurate and timely information. Traditional accounting systems fail to detect and measure the benefits of
Figure 1.1. Payback periods used by U.S industries to justify automation according to the NAA.

From Baer, 1988
automation. These systems are often a hindrance to justifying automation. In recent years most managers and companies have realized the problems of using traditional accounting systems and they are beginning to experiment with new techniques and tools.

Some managers blame the following causes for the lack of investment in new equipment and technologies: high income and capital gain taxes, public policies, federal regulation, rising energy prices, inflation, and so on. While some of these factors may have some merit, they do not explain the lack of capital. For an example, in the 1970's the ratio of shareholders dividends to the total corporate operating cash flow was higher by about 11% from the 1950's, and by 30% in the 1980's. While the ratio of investment in new equipment declined (Hayes), one can conclude that it's not because of the lack of capital, but rather the lack of initiatives and reinvestment strategies.

1.3 Objective

The objective is that when one evaluates a modernization project (new technology), if the project promise to improve or has improved the firm's standing or provide opportunities (better quality, lower inventory, better customer service, and so on), then the project justification process should include not only the project cost saving, but the effects of these opportunities.

Since the introduction of CIM a number of questions or problems have dogged accountants and manufacturing engineers. How do you put a dollar value on opportunity costs? Should you put a dollar value on them? Up to now accountants have failed to quantify
opportunity costs such as: better quality, flexibility, customer satisfaction etc. However, this should not be used as an excuse for not including or considering such opportunities in the justification process.

The overall objective of this research effort is to develop a general purpose algorithm (methodology), and to write a software package that will assist the user in the justification process for new technologies and automation. The problem with traditional justification approaches is that they are often based on short terms, and long production runs. Future justification methods must take into account recent new and existing manufacturing strategies and conditions.

It is difficult to reduce as complex a subject as this to a simple algorithm; consequently the software package will be based on two approaches: strategic, and financial. The strategic approach will help the user in developing and adopting a long-term strategy. The tactical approach can be adopted by the user if he or she desires, and it will be based on engineering economy. The user may have the option of combining both approaches to reach a solution.

1.4 General Approach

The late Dr. Joseph Harrington, in his book, *Computer-Integrated Manufacturing* (1973), said, "justification must be a matter of conviction, not a matter of accounting. Put another way, justification is a policy decision, not an investment decision. True, substantial investments are involved, and the financial resources of the corporation must be most carefully considered. But these factors
will govern the rate of investment in computer-integrated manufacturing, not the decision to invest."

The author agrees with Dr. Harrington, and believes that the first step to justifying new technologies is a matter of policy and of long-term strategy—the creation of a strategic manufacturing plan based on the long term objectives and goals of the organization. The concepts should be based upon a solid understanding of the current environment and the objectives for the future with ongoing and newly created programs and concepts which will provide for the transition from the current environment to the future environment, based upon the stated objectives. The organization's manufacturing strategy must be an integral part of the firm's competitive strategy or policy.

The proposed software will have several options, which the decision maker can choose to reach a decision. One option of the software will assist the user in carrying out the above policy or program. The proposed justification methodology uses a linear additive modeling approach to aid a decision maker in evaluating the organization's strategic objectives based on a set of benefits (attributes), or opportunities.

Another option allows the decision maker to evaluate proposals based on traditional investment justification methodologies, and will include several financial methods.

The third option allows the user to evaluate various alternatives. This evaluation process will take into account both strategic (non-monetary attributes) and financial attributes. The approaches and the algorithms are discussed in more detail in Chapters 3 and 4.
Chapter 2
Literature Review

In this chapter the author reviews several articles and papers that deal with the subject of justifying new technologies and automation. These articles were chosen because they each represented a different view-point of the problem and/or suggested a different approach to justifying automation and new technologies. Traditional justification methodologies and strategic approaches are reviewed, along with other methods or techniques that are currently being used or can be used in the justification process.

Traditional justification methodologies that were based on financial justification procedures were adequate when there was a relatively stable economy, market, and technology, with long standard runs. These procedures were mainly based on internal rates of return, payback periods etc. Huber (1985) emphasized the need for new methodologies and techniques in a 1985 article in which he interviewed a number of CEO's, who agreed on the need for new concepts and approaches to the justification process. For example, Pearson Gram of TRW Inc. stated that, "You must start with a strategy, not with the investment. If you try to start with the investment, you're starting in the middle. By starting with the strategic plan for the company, and a strategic plan for manufacturing, we perceive we are starting at the beginning." If one starts with a strategic plan taking into account future
environments, thus preventing the competitors from taking part of the market share by anticipating that they will take new manufacturing/technological approaches and actions, it will mean that the organization is taking stock in it's future.

The manufacturing environment has changed, we live in a highly competitive global market, with an ever changing market and technology. Therefore the justification process should include benefits and opportunities that simply cannot be calculated. Steve E. Klabuade, Vice President, Manufacturing Systems, Gidding and Lewis Inc., Janesville, WI, used quality control as an example in making the following point: "It is impossible to put precise figures on benefit or better quality, yet you know it can be invaluable to you in certain markets. The benefit lies, for example, in less scrap and salvage since you're making the product right the first time. You'll have lower warranty costs, lower service calls and lower service costs. As your product's reputation for quality becomes known in the market place, your share of the market will increase." While Huber and the CEO's discussed the barriers to the justification of CIM and other new technologies, there was no specific suggestion or recommendation of a preferred methodology. However, they all agreed on the need to include opportunity costs in the justification process of automation and new technologies.

Bonsack (1988) suggested that traditional justification methods should be refined and modified through life-cycle costing, risk analysis, sensitivity analysis, and considerations that take into account the effects of government grants, taxes, and inflation. In the life cycle analysis of the new technology all expenditures and benefits over the expected life should be identified and taken into
account in the justification process. But the estimation process becomes very difficult as time progresses into future years. Break even analysis must be refined by classifying investments as to their relative risk or safety. The probability of the level of risk and the reliability of the forecasting scheme should be measured for the particular activity. Sensitivity analysis is a helpful tool in identifying potential areas for improvement. It is conducted by making use of figures which are “best estimates” of future events: “investments are assessed based on pessimistic, most likely, and optimistic criteria.” Further, projects must be assessed after tax rather than before tax, and the effects of inflation on the life cycle must be taken into account in the evaluation process. Unfortunately he did not explain or suggest how the benefits could be quantified into dollars to be included in the financial analysis.

Sullivan (1986) proposed that justification should include non-monetary factors. He described approaches that deal with multiple conflicting objectives and non-monetary features (opportunities). These approaches are known as profile charts. The first step is to choose several mutually exclusive criteria that can be used to judge the differences among the different alternatives. Each alternative is evaluated based on meeting these criteria, and a score is given by the evaluator based on a predetermined scale. The results are presented visually on a profile chart. Figure 2.1 is an example of a profile chart that describes how a particular alternative meets certain criteria. As an example, the criterion “Effects on Increased Annual Sales” can be evaluated as follows:

-2 = less than $100,000
-1 = $ 100,000 to $200,000
Figure 2.1. Example of a profile chart for two alternatives.

From Sullivan 1986.
**Figure 2.2. Example of symbolic scorecard for evaluation of CAD system**

From Sullivan 1986.
$1 = $200,000 to $400,000
$2 = more than $400,000

The scale has a range from -2 to +2. Notice that "no change" should be plotted, and uncertainty can be indicated by showing two or more values (shading more than one box). Another type of profile charts is called a symbolic scoreboard. Figure 2.2 is an example of selecting a CAD system from three vendors. Each color represents a level of desirability, from "best" to "worst". Sullivan claims that these charts have the following advantages:

1. They are less difficult, since there is less confusion about assigning weights for each criteria.
2. The charts focus on relevant differences among alternatives, and can provide the evaluator with mental tradeoffs in making the selection.
3. The evaluator defense of precise numerical estimates is lessened.

Profile charts do not attempt or indicate the relative importance of the criteria. Each criterion is given an equal importance.

A different approach was taken by Goodwin (1988), who believes that a significant obstacle to the justification of automation is the conflict in disciplines between finance and engineering. He points out that the people in each field have a different type of education, and there is a lack of familiarity with each other's fields. "Financial analysis tools are not familiar to engineering managers. The opposite is also true." He feels that current corporate accounting practices are a barrier to implementing computer-integrated manufacturing. Particularly
those methods that are aimed at producing pricing information, providing inventory values, and controlling costs. "These simple tools generally fail to detect and measure the many benefits of automation." He believes that automation investments are best analyzed by using discounted cash flow techniques, particularly the present worth value/cost-benefit analysis. He feels that this technique is advantageous because it...

- Incorporates the idea that benefits derived from automation are balanced by the cost of capital for the company, tax impacts and the cost of financing the investment.
- Offers a more realistic picture of the present and future costs and benefits of an automated system.
- Takes into account the amount and timing of cash inflows from the automation investment.
- Produces a single figure, the total of cash inflows and outflows over the lifetime of the equipment providing a much more precise measure of the worth of an automation investment, and making comparison with other investments much simpler.

However the problems with such an analysis tool are the selection of the right discounted rate to be used, the lifetime of the equipment, and the translation of the benefits from automation into yearly quantifiable inflows.

Kaplan (1986) viewed the problem somewhat differently. He does not believe that financial methods, particularly discounted cash flow (DCF), are inadequate or a hindrance to justifying CIM or other investments. The problem is most often is how DCF methods are used. He argues, "But must there be a fundamental conflict between the financial and the strategic justification for CIM? It is
unlikely that the theory of discounting future cash flow is either faulty or unimportant: receiving $1 in the future is worth less than receiving a $1 today." He believes the problem lies with high hurdle rates set by management for evaluating new investment, and their demand for quick return on investments in a short amount of time, usually 3 to 5 years. Another problem is that management often fails to evaluate all the relevant alternatives properly. Evaluation often is done between the new investment and the status quo, where the assumption is that the status quo will continue to have positive effects on the current market share, selling price, and cost. In reality the status quo rarely continues to operate undisturbed. He believes that the first step is to remedy the problem of high hurdle rates and short payback periods required by the financial community. Once this is done then DCF methods can be used to evaluate CIM investments. Should an investment not pass the hurdle rate then the next step is to quantify its benefits and use the DCF once again to evaluate the investment.

There is a wide variety of software packages and advanced programs on the market. "These tools include factory simulation, network queuing, group technology and expert systems." These tools were not designed for cost justification purposes, but Benassi (1988) suggested that these tools can often be used to justify CIM. Simulation packages are used to simulate production models, cost, work in process, inventory, and so on. Network queuing systems are used in evaluating both existing production lines and newly purchased machines. Such analyses usually include: workload, production lead time, and estimates of product costs. Group technology tools are used in process planning. The main objective is
standardization of designs, thus generating cost savings. The suggestion is that these tools can be used in the justification process with some success. However they should not be a substitute for an effective justification program, but rather an aid or a tool to be used by the evaluator. The drawback to these tools is that they require a data-base which is often unavailable to the evaluator. They also tend to be expensive in terms of time and money.

Canada (1986), suggested that justification methods that are based on traditional engineering economy and financial approaches are inadequate and often will block the justification of CIM/or CAM. The reason is because these approaches are better suited to meeting profitability criteria than evaluating ways of reaching long term strategic goals. He approached the problem by using a common procedure and by considering investment projects in two categories:

Opportunities, which are independent of each other (they do not affect each other). See Figure 2.3.

Alternatives, which are mutually exclusive (at most one alternative can be chosen in a group of opportunities). See Figure 2.4.

The opportunities are weighted based on their importance; then these weights are normalized. Each alternative is given a score of 0 to 10 for meeting each opportunity. Then the weight of each opportunity is multiplied by the alternative score. The scores for each alternative are added up, and the alternative with the highest score is usually chosen. Basically, it is a form of the linear-rating additive model, with weighted scale of 0 to 100 and alternative ratings between 0 and 10.

Klein 1988, reported on several U.S firms and the methods they use to justify automation and new technology. The rest of this
Check One:  

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<th>Check if Applicable</th>
<th>Weight</th>
<th>Normalized Weight</th>
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<td>20. Compatability</td>
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<td>21. Serviceability</td>
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<tr>
<td>22. Other</td>
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Total Weight = 250  Total = 100

**Figure 2.3**
Identification and Weighting of Total Tactical Attributes

From Canada, 1986.
Check One: 
- Strategic
- Tactical

Project Description:
P-1 ALT. 1 - A
P-2 ALT. 1 - B
P-3

What: ILLUSTRATION OF WEIGHTING Evaluation of Alternatives

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<td>Riskiness, Lack of</td>
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<tr>
<td>Serviceability</td>
<td>20</td>
<td>10</td>
<td>7.5</td>
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<tr>
<td>MGT/ENG's Efforts</td>
<td>15</td>
<td>8</td>
<td>6</td>
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</table>

Total 82 75

Monetary Measure of Merit, Like Net P.W. 

*300 350

(if considered separately)

Figure 2.4
Weighting Evaluation of Alternatives

From Canada, 1986.
chapter will explore these firms and their justification methods.

In the past, Whirlpool used return on investment (ROI) as the driving factor for justifying new technologies. A 20% return on investment was required before a project was implemented. Whirlpool has made major investments in modern manufacturing technology and is considered to have some of the most advanced manufacturing facilities in the industry. ROI is still used, but it is not the primary factor; other factors must be considered and weighted. Before investing in automation projects, the feasibility of improving existing operations is first considered. They look at improving the existing systems if possible. Justification of proposed expenditures is left up to each individual business unit. Joint efforts of the functional representatives, such as marketing, engineering, manufacturing, finance, and procurement are responsible for analyzing and improving profitability of their own product lines. They must make convincing cases that the reduction in the total cost of the product (without adversely affecting the product’s quality) versus the cost to achieve that reduction is acceptable; then the project will be funded.

Lennox Industries (Dallas, Texas), in the past used first year pay back in justifying new equipment. However, it is impossible to justify current technology based on first-year pay-back. Now, Lennox looks at pay back over the expected life of the equipment. The expenditures and benefits over the life cycle of the project are identified and brought to year zero (present worth), and pay back analysis is performed. Comparison between alternatives and existing equipment are analyzed and compared based on life-cycle pay-back. Management decides on the preferred investment.
Thirty-three manufacturing companies participated in the Cost Management System at the industry consortium, Computer-Aided Manufacturing-International Inc. This includes companies such as General Dynamics, Martin-Marietta Energy Systems, and Lockheed. The system is intended to aid and guide companies in making decisions to invest in new technologies. The purpose of the project is to develop a model that will allow companies to arrange their goals subjectively in order of priorities. Cost Management System, CMS, uses a multiple-attribute decision model. It allows the user to enter three factors. The first factor is financial (pay back, present worth, or any other). Then quantitative non-financial values are added. These might include throughput time, process yield, lead times etc. Finally the user enters subjective factors, such as basic research and development, technology obsolescence, and product obsolescence. Each factor is assigned a weight based on it's importance to the company. The sum of the weight must equal 100 points. After compiling this quantitative and qualitative information, each factor is weighted according to the company's goals and priorities. Confidence levels are assigned to each factor. High levels of confidence receive higher values. The user multiplies the three tabulated values for each factor weight, value, and confidence level. The resulting products are added to obtain a score for the model. CMS is intended as a guideline. Projects with higher scores are evaluated and the question of why a project scored more than another is also examined. It is subjective. Thus the user be must very familiar with the firm's goals and priorities.

It is clear that the literature suggests that there is no one generic justification methodology or technique, but rather a wide
variety of methods and approaches ranging from financial justification methods to purely subjective or "must" methods. However there is an agreement by most experts on the need to include benefits and opportunities in the evaluation process of automation and other new technologies. Disagreement remains on how to include these opportunities and how to quantify/or put a dollar value on them. Another area of disagreement is on the need for new accounting methods and approaches. Current accounting methods were designed for different times and technologies. They do not adequately apply to today's technology.

This thesis will attempt to remedy the problem of justifying new technologies by the development of an approach based on some of the methods reviewed in the literature. It will be based on strategic and financial justification methodologies. The package that will be developed can be used as an effective tool by the evaluator in reaching strategic and tactical decisions. A justification procedure or program will be designed that can be effectively used by organizations seriously interested in their future. Justification of automation or new technologies is not a science, but rather an art, and those firms that master this art will prosper.
Chapter 3

JUSTIFICATION METHODOLOGIES

Chapter 3 is divided into two sections: the first section describes some of the popular financial justification methodologies. Examples are provided on each method. The second section describes strategic methods for justifying CIM's and other technologies which include benefits and opportunities.

3.1 Traditional Financial Methods

Since all the methods that will be discussed in this section are related to the cash flow concept, it's worthwhile first to review cash flows. Cash flow is simply, the sum of all money flowing in (inflow) and out (outflow) of a firm during a period of time. We will use the negative sign to refer to outflow and positive for inflow. The cashflows for each year will be assumed to occur as discrete amounts at the end of their respective years, thus allowing us to use discrete interest factors in the calculation process. The net cash flows can be mathematically expressed by the equation

\[ CF_t = (G_t - C_t - I_t) - (G_t - C_t - D_t - I_t) T \]

Multiplying by \( T \), and combining terms gives

\[ = (G_t - C_t - I_t) - (G_t - C_t - I_t)T + D^*T \]

and factoring out like terms

\[ = (G_t - C_t - I_t) (1 - D^*T/T) \]
\[
(C_{t} - C_{t} - I_{t}) (1 - T) + DT
\]

where

- \( CF_{t} \) = the net cash flow during \( t \)
- \( G \) = the gross income from the project (inflow)
- \( C_{t} \) = total expenses during \( t \) (outflows), excluding interest paid on project debt
- \( D_{t} \) = depreciation during \( t \)
- \( I_{t} \) = interest paid on borrowed capital for the project
- \( T \) = the effective ordinary income tax rate

Financial methods are based on financial or economic performance, which means identifying the costs and benefits that are associated with each alternative and selecting the one that "best" meets the preset criteria (hurdle rate, payback period etc.). The most widely used or popular methods that are currently being used to justify CIM and other technologies (see Chapter I, Background), are discussed below:

- The Payback Period
  - without interest
  - with interest (discounted)
- The Discounted Cash Flow
  - net present value (NPV)
  - internal rate of return (IRR)
- Project Balance
- Capital Recovery
3.1.1 The Payback Period

Basically, the payback period method calculates the number of years required to recover the initial investment. A zero interest rate is assumed in the calculation. The alternative with the least amount of years of recovery is recommended or selected. This method is generally accepted as a useful first financial test and it can serve as an indicator of risk when used in conjunction with the discounted cash flow methods. The shorter the payback period, the less risk is involved. The payback period can provide useful information by giving some measure of the rate at which an investment will recover its initial outlay. It can also provide information on the firm’s cash flow position and borrowing commitments related to the investments that are under consideration. There are several advantages to the use of this method in comparison to other financial methods, (Canada and White 1980), they are as follows:

- Easy to compute and understand.
- Does not require interest rate in the calculation.
- Hedge against errors in estimating future cash flows.
- Investment capital is limited and must be recovered quickly.

The drawback and weakness of this method is that it does not take into account the time value of money, or future cash flows after the break even point—that is, any future flows after the payback period are not considered in the calculation. Thus it is biased against alternatives that generate higher cash flows and returns in later years. This method does not necessarily result in the same recommendation as obtained using the discounted cash
flow method. Also this method is inadequate for rigorous evaluation of all the associated variables and systematic comparison of alternatives.

The payback period can be expressed mathematically as follows:

\[
L = \sum_{t=0}^{\infty} CF_t \geq 0
\]

\[L = 5 + \frac{5,000}{10,000} = 3.5 \text{ years.}\]

**Example 3.1**

Given the cash flows in Table 3.1 for certain project, determine the payback period.

- sum of cash flows for the first 3 years is
  - \(-20,000 - 5,000 + 10,000 + 10,000 = -5,000\)
- and for the first 4 years is
  - \(-20,000 - 5,000 + 10,0000 + 10,0000 + 10,0000 = 5,0000\)
- thus, \(L = 5 + \frac{5,000}{10,000} = 3.5 \text{ years.}\)
Table 3.1. Cash Flows For Example 3-1

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-20,000</td>
</tr>
<tr>
<td>1</td>
<td>-5,000</td>
</tr>
<tr>
<td>2</td>
<td>10,000</td>
</tr>
<tr>
<td>3</td>
<td>10,000</td>
</tr>
<tr>
<td>4</td>
<td>10,000</td>
</tr>
<tr>
<td>5</td>
<td>10,000</td>
</tr>
<tr>
<td>6</td>
<td>10,000</td>
</tr>
</tbody>
</table>

Payback with interest. The payback period fails to consider the time value of money. A modified method known as the discounted payback period includes the time value of money. Basically, this method determines the length of time is required until an investment's receipts equal the equivalent capital outlays. Mathematically it can be written as follows:

\[
L = \sum_{t=0}^{\infty} \frac{CF_t}{(1 + i)^t} \geq 0 \tag{3.5}
\]

\(i = \text{interest rate}\)

All other variables are the same as the variables in equation 3.4.
Example 3.2
Given the same cash flows as in example 3.1 and Table 3.1, determine the payback period at an interest rate of 15%.

\[ \text{sum of cash flows discounted for 5 years} \]

\[ -20,000 - 5000/(1.15)^1 + 10,000/(1.15)^2 + 10,000/(1.15)^3 + 10,000/(1.15)^4 + 10,000/(1.15)^5 = 478 \]

\[ L = 4.9 \text{ years} \]

It's interesting that by taking the time value of money at 15%, the payback period increased by almost one and a half years.

3.1.2 Discounted Cash Flows

The discounted cash flow approach relates the flow of money and its timing over the life of the proposed investment as it was illustrated in the payback period with interest. Basically, this method consists of finding the interest rate that discounts future earnings of a project down to present value equal to the project cost. This interest rate is the rate of return on the investment. In other words, this method is based on the principle that in making an investment outlay we are actually buying a series of future annual incomes. Discounted cash flow takes into account the amount and timing of money inflows from the project making it superior to payback and rate of return methods. It produces a single figure of inflows and outflows over the lifetime of an investment, making it a more precise measure of the worth of the project.
Internal rate of return (IRR). Internal rate of return is the interest rate that makes the sum of the net cash flows, discounted to time zero, equal to zero. Another way of stating this concept is that the interest rate causes the equivalent receipts of a cash flow to equal the equivalent disbursement of that cash flow. It is widely accepted as an index of profitability. Mathematically it’s expressed as follows:

\[ 0 = NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t} \]

where
- \( CF_t \) = net cash flow in year \( t \)
- \( n \) = life of the investment (number of years)
- \( t \) = the year in which the cash flow occurs
- \( i \) = the internal rate of return (IRR)

**Example 3-2**
Assume that the net cash flows for a particular investment are given in Table 3-2. Using Equation 3-5, the internal rate of return is

\[ 0 = -20,000 + \frac{5,000}{1+i} + \frac{5,000}{(1+i)^2} + \ldots + \frac{5,000}{(1+i)^n} \]

\[ 0 = -20,000 + 5,000 \cdot \frac{P/A,i,6}{P/A,i,6} \]

\[ P/A,i,6 = \frac{20,000}{5,000} = 4 \]

\[ i = 8\% \]
Internal rate of return (IRR). Internal rate of return is the interest rate that makes the sum of the net cash flows, discounted to time zero, equal to zero. Another way of stating this concept is that the interest rate causes the equivalent receipts of a cash flow to equal the equivalent disbursement of that cash flow. It is widely accepted as an index of profitability. Mathematically it’s expressed as follows:

\[
0 = NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t}
\]

where

- \(CF_t = \text{net cash flow in year } t\)
- \(n = \text{life of the investment (number of years)}\)
- \(t = \text{the year in which the cash flow occurs}\)
- \(i = \text{the internal rate of return (IRR)}\)

**Example 3-2**
Assume that the net cash flows for a particular investment are given in Table 3-2. Using Equation 3-5, the internal rate of return is

\[
0 = -20,000 + \frac{5,000}{(1+i)^1} + \frac{5,000}{(1+i)^2} + \ldots + \frac{5,000}{(1+i)^n}
\]

\[
0 = -20,000 + 5,000 \left(\frac{P/A, i, 6}{5,000}\right)
\]

\[
P/A, i, 6 = \frac{20,000}{5,000} = 4
\]

\[
i = 8\%
\]
Table 3.2. Cash Flows For Example 3-1

<table>
<thead>
<tr>
<th>Year</th>
<th>Net Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-20,000</td>
</tr>
<tr>
<td>1</td>
<td>5,000</td>
</tr>
<tr>
<td>2</td>
<td>5,000</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
</tr>
<tr>
<td>4</td>
<td>5,000</td>
</tr>
<tr>
<td>5</td>
<td>5,000</td>
</tr>
<tr>
<td>6</td>
<td>5,000</td>
</tr>
</tbody>
</table>

In example 3-2 the cash flows were constant annual amounts; thus the calculation of the IRR is rather simple and straightforward. In reality this is often not the case because the internal rate of return must be determined through a trial and error procedure. The first step is to determine two IRR’s, one that gives a positive result and another that gives a negative result. This is shown in Table 3-4. The IRR is approximated through linear interpolation.

\[ i = \text{IRR} = 6 + 2 \frac{(225.4 - 0)}{(225.4 + 825.6)} = 6.43\% \]

The trial and error process is not difficult, but it is time consuming. However, through a simple computer program it can be solved very efficiently. The acceptance of an investment is based on a comparison between the IRR and a required hurdle rate (HR) set by management. If the IRR \( \geq \) HR, then the project is accepted; if it is
not, then the project is rejected.

Table 3.3

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cash Flow</th>
<th>Discounted Cash Flows P/F.6%</th>
<th>Discounted Cash Flows P/F.8%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P/F.6%</td>
<td>P/F.8%</td>
</tr>
<tr>
<td>0</td>
<td>-20,000</td>
<td>1.0000</td>
<td>-20,000</td>
</tr>
<tr>
<td>1</td>
<td>6,000</td>
<td>.9434</td>
<td>5,660.4</td>
</tr>
<tr>
<td>2</td>
<td>3,000</td>
<td>.8900</td>
<td>2,670</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>.8396</td>
<td>4,198</td>
</tr>
<tr>
<td>4</td>
<td>5,000</td>
<td>.7921</td>
<td>3,198</td>
</tr>
<tr>
<td>5</td>
<td>5,000</td>
<td>.7473</td>
<td>3,736.5</td>
</tr>
<tr>
<td>SUM</td>
<td></td>
<td></td>
<td>225.4</td>
</tr>
</tbody>
</table>

It is possible in rare situations to have more than one IRR. This situation may occur when the cash flows have more than one sign change (from net outflow to net inflow or the opposite) over the period of study. Descartes' rule of signs explains this situation. This rule states that for an nth-degree polynomial, the number of real positive roots is never greater than the number of sign changes in the sequence of its coefficients. An effective way to overcome this is to manipulate cash flows as little as possible so that there is only one reversal of the cumulative net cash flow.

The Net Present Value (NPV). The net present value is the sum of the net cash flows discounted to time zero at a hurdle rate of return or minimum attractive rate of return. This method of analysis can provide a measure of equivalence. Thus it is a
consistent base for comparison of alternatives. It is expressed mathematically as follows:

\[ NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+HR)^t} \]

\[ HR = \text{the hurdle rate set for return} \]
\[ = \text{All other variables the same as equation 3.5} \]

**Example 3-3**
Calculate the net present value of the cash flows that are given in Table 3.2 with a HR = 12%

\[ NPV = -20,000 + 5,000(P/A, 12\%, 6) \]
\[ = -20,000 + 5,000(4.114) \]
\[ = $557 \]

The decision to accept or reject a project is based on the NPV. If the NPV < 0 then the project is rejected. Thus in example 3-3, the project would be accepted.

**3.1.3 Capital Recovery With Return**

Capital equipment and systems lose value over time when used to carry out the activities of the organization. These losses of value are expressed as annual equivalent terms which include the time
value of money. These terms represent the original capital cost and the final salvage value of the asset. It is assumed that purchased assets will earn more than they cost. If it is assumed that the depreciation amount represents the capital recovery, then other incomes derived from service rendered by the assets and from its sale at the end of its life cycle (salvage value) can be said to provide return on the investment.

Summing up, capital recovery must include the original cost of the asset, the salvage value at the end of useful life, and the opportunity to earn interest on the invested capital. These losses are given as annual equivalent amounts. The annual equivalent amounts are expressed as

\[ CR(i) = P \left( \frac{A}{P, i, n} \right) - \text{SALV} \left( \frac{A}{F, i, n} \right) \quad \text{3.7} \]

since

\[ \left( \frac{A}{F, i, n} \right) = \left[ \left( \frac{A}{P, i, n} \right) - i \right] \]

substituting

\[ CR(i) = P \left( \frac{A}{P, i, n} \right) - \text{SALV} \left[ \left( \frac{A}{F, i, n} \right) - i \right] \quad \text{3.8} \]

factoring

\[ CR(i) = (P - \text{SALV}) \left( \frac{A}{P, i, n} \right) + \text{SALV} \times i \quad \text{3.9} \]

\[ CR(i) = \text{capital recovery with return} \]

\[ P = \text{first cost of the asset} \]

\[ \text{SALV} = \text{estimated salvage value} \]

\[ n = \text{estimated service life in periods (years)} \]

\[ i = \text{interest rate} \]
Example 3.4

Given an investment with an initial cost of $10,000 and a salvage value of $1,000, determine the annual recovery with return. The investment has an estimated life of 5 years and an interest rate of 10%. The annual recovery with return is:

\[
CR(i) = (10,000 - 1,000)(0.2638) + (1,000 \times 0.10) = $2,474.20/period.
\]

3.14 Project Balance

Project balance analysis can be useful in assessing risk or loss of an investment. It describes, period by period, how much committed capital is exposed to risk or loss should the project be terminated at a particular period. It identifies the equivalent amount of dollars that are committed to a project at each point in time of the life of the project. It can also be used to identify when an investment becomes profitable. This occurs when the equivalent receipts exceed the equivalent disbursements. Project balance is defined as

\[
PB(i)_t = \sum_{t=0}^{n} CF_t(1+i)^{t-1}
\]

where

- \(PB(i)_t = \) project balance
- all other variables are the same as in previous equations.
The period's capital that are committed can be plotted as a project balance diagram which has the following characteristics:

1. The net future worth of an investment at any period in time.
2. The time of the break-even point, which is when the committed dollars switch from negative to positive cash flows.
3. The net equivalent committed dollars that are exposed to risk or loss.
4. The net dollars earned in the positive area of the diagram.

**Example 3.5**
Given the cash flows that are showing in Figure 3.1 of a certain asset, determine the project balance at the end of each year.

Using equation 3.10 we obtain the annual project balance. The results are plotted into a project balance diagram. See Figure 3.2.

### 3.2 Depreciation

Depreciation can be considered or defined as the loss of value of a capital asset over a period of time through wear, deterioration, obsolescence, and the passage of time. Whatever is the reason for this reduction of value, the cost must be accounted for. The initial cost of an investment must be distributed over its useful life. This initial investment is recovered over the life of the asset in periodic amounts through depreciation.

In the past, choosing a depreciation method was very important. It meant choosing when and how to recover the initial
Figure 3.1. The cash flows of a certain project.

Figure 3.2. Project balance diagram of cash flows in Figure 3.1.
investment. Also, depreciation and the method of allocating depreciation are important from the standpoint of taxes since depreciation is a deduction from the taxable income. For example, if an organization chose the straight line model it meant equal periodical amounts of recovery. However, if the choice was the sum of years-digit model, then the capital is recovered at higher amounts in the early periods (years) than in the later years of the life of the asset.

The passage of The Tax Reform Act of 1986 represents the most complete revision of the tax code of the last four decades. It meant that traditional depreciation methods cannot be used for new investments. However, there has been pressure from the business community on the government to reverse this Act and allow the use of traditional models once again. A decision was made to include traditional depreciation methods because the package can be used as a teaching aid. Therefore it is worthwhile to include some of the traditional models. The following methods will be briefly discussed and are included in the software package; they are:

- Straight Line Depreciation
- Sum of Years-Digits Depreciation
- Double Declining Depreciation
- Modified Accelerated Cost Recovery System (MACRS 1987 and later)

3.2.1 Straight Line Depreciation

The straight line depreciation model assumes that the value of
an asset decreases at a constant rate. That is the book value decreases at a constant rate. The capital recovery is distributed at an equal amounts over the useful life of the asset. Basically, it is defined as

\[ D_t = \frac{(P - SALV)}{n} \]  

\( D_t \) = depreciation in period \( t \)

= All other variables are the same as in previous equations.

**Example 3.6**
The initial cost of an asset is $10,000 and the estimated salvage value of $1000. The asset has a useful life of 10 years, determine the depreciation.

\[ D_t = \frac{($10,000 - $1,000)}{10} = $ 900/\text{year} \]

**3.2.2 Sum of the Years Digits Depreciation**

The sum of the years digits depreciation model assumes that the value of an asset decreases with time. That is, the rate decreases by the same amount from period to period. Therefore the value of the asset is recovered at higher amounts in the early years than in later years of the asset. Consequently, the book value decreases at a decreasing rate. The sum of the years-digits for any number of years \( n \) can be computed as
The depreciation amount in the year $t$ can be expressed as

$$D_t = (n - t + 1/(n(n+1))/2) \cdot (P - SALV)$$

= All variables are the same as in equation 3.9.

**Example 3.7**

Given the same data as in example 3.6

$$SYD = (10 \times 11)/2 = 55$$

$$D_t = 10/55 \cdot (10,000 - 1,000) = 1636.36$$

Table 3 provides a complete list of the depreciation. Note that the total depreciation over the useful life of the asset should equal the initial asset minus the salvage value.

**Table 3.4.** Depreciation results of example 3.7 using the sum of years-digits model

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Depreciation</th>
<th>End of Year</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,636.4</td>
<td>7</td>
<td>654.5</td>
</tr>
<tr>
<td>2</td>
<td>1,472.7</td>
<td>8</td>
<td>490.9</td>
</tr>
<tr>
<td>3</td>
<td>1,309.1</td>
<td>9</td>
<td>327.3</td>
</tr>
<tr>
<td>4</td>
<td>1,145.5</td>
<td>10</td>
<td>163.6</td>
</tr>
<tr>
<td>5</td>
<td>981.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>818.2</td>
<td><strong>Total</strong></td>
<td>9,000</td>
</tr>
</tbody>
</table>
3.2.3 Double-Declining Balance Depreciation

The declining balance method of depreciation assumes that an asset decreases in value faster early rather than in the later portion of its service life. It is sometimes referred to as the fixed-percentage depreciation model because the depreciation amount varies from period to period by a fixed percentage. Basically the depreciation amount for a particular year is determined by multiplying the book value at the beginning of the year by a fixed percentage. Mathematically, this can be expressed as

\[ D_t = r(B_{t-1}) \]  \hspace{1cm} (3.14)

where:
- \( r \) = a fixed percentage
- \( B \) = book value
- \( t \) = the period of interest

The book value at the end of a particular year is

\[ B_t = (1-r)^t \times P \]

substituting for \( B_{t-1} \)

\[ D_t = r(1-r)^{t-1} \times P \]  \hspace{1cm} (3.15)

When \( r \) is calculated as \( 2/n \), then the model is called double-declining balance depreciation method.

Example 3.8

Given the same data as example 3.6.

Table 3.5 provide a complete solution of problem 3.8. Note that in the last year (10) the depreciation amount is adjusted so that the
book value will equal the salvage value. Put another way the total depreciated amount must equal the initial investment minus the salvage value, 10,000 - 1,000 = 9,000.

Table 3.5. Using Double-Declining Depreciation Model

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Depreciation</th>
<th>End of Year</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,000.0</td>
<td>7</td>
<td>524.4</td>
</tr>
<tr>
<td>2</td>
<td>1,600.0</td>
<td>8</td>
<td>419.4</td>
</tr>
<tr>
<td>3</td>
<td>1,280.0</td>
<td>9</td>
<td>335.5</td>
</tr>
<tr>
<td>4</td>
<td>1,024.0</td>
<td>10</td>
<td>342.2</td>
</tr>
<tr>
<td>5</td>
<td>819.2</td>
<td>Total</td>
<td>9,000</td>
</tr>
<tr>
<td>6</td>
<td>655.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2.4 Depreciation Based on Usage

This model assumes that depreciation is based on the use of the asset in a particular year with respect to the lifetime use of the asset. It is defined as

\[ D = \left( \frac{P - SALV}{\text{Lifetime usage}} \right) \times (use) \]  

From the standpoint of taxes, depreciation charges are calculated after the fact; that is, when the actual yearly use is known or estimated.

Example 3.9

Given an initial investment of $10,000 and a salvage value of 1,000 at the end of a 10 year period, lifetime production of the system of
100,000 units, and an annual production of 10,000 units, determine the depreciation charges through the usage model

\[ D = [10,000 - 1,000] \times \frac{10,000}{100,000} = $900/\text{year} \]

### 3.2.5 Modified Accelerated Cost Recovery System (MACRS)

The Tax Reform Act of 1986 allows the use of two depreciation models. The salvage value is not used and declining balance switches to straight line depreciation. A half year convention is used for the year the asset was placed in service and the year of its disposal. Put another way only half the depreciated amount is allowed or accounted for in those years. It is expressed as

\[ D_t = \frac{B_0}{2n} \quad \text{for } t = 1 \text{ and } t = n + 1 \]

\[ D_t = \frac{B_0}{n} \quad \text{for } t = 2, 3, 4, \ldots, n \]

The declining balance follows the same logic as discussed in section 3.2.4. However the percentage \( r \) is set by the IRS. Only two percentages are allowed: 200% and 150% (2 \& 1.5) depending on the life of the asset. For assets with a useful life of less than 15 years, 200% is used; for assets with a useful life of 15 or more years, 150% is allowed. This method is expressed as

\[ D_t = (0.5r)\frac{B_0}{n} \quad \text{for } t = 1 \]

\[ D_t = \frac{rB_{t-1}}{n} \quad \text{for } t > 1 \]

and for straight line depreciation it is expressed as
\[ D_t = \frac{1}{2} \frac{B_0}{n} \quad \text{for } t = 1 \quad 3.21 \]
\[ D_t = \frac{B_{t-1}}{(n-t+1.5)} \quad \text{for } t > 1 \quad 3.22 \]
\[ D_{t+1} = B_n \quad \text{for } t = n+1 \quad 3.23 \]

When the declining balance depreciation in this model becomes less than the depreciation using the straight line method, then a switch is allowed to straight line depreciation for that year. Only one switch is permitted.

**Example 3.10**

Given an initial investment of $10,000, the estimated life of the project is 5 years. Determine the depreciation charges using MACRS double declining model.

\[ r = 200\% \text{ for } n = 5 \]

**Double declining depreciation**

\[ D_1 = \frac{1}{2} \left( \frac{2}{5} \right) 10,000 = 2,000^\dagger \]
\[ D_2 = \frac{2}{5} \left[ 10,000 - 2,000 \right] = 3,200^\dagger \]
\[ D_3 = \frac{2}{5} \left[ 8,000 - 3,200 \right] = 1,920 \]
\[ D_4 = \frac{2}{5} \left[ 4,800 - 1,920 \right] = 1,152^\dagger \]
\[ D_5 = \frac{2}{5} \left[ 2,880 - 1,152 \right] = 691.2 \]

**Straight line depreciation**

\[ D_1 = \frac{1}{2} \left( \frac{10,000}{5} \right) = 1,000 \]
\[ D_2 = \frac{10,000 - 2,000}{4.5} = 1,777.8 \]
\[ D_3 = \frac{8,000 - 3,200}{3.5} = 1,371.4 \]
\[ D_4 = \frac{4,800 - 1,920}{2.5} = 1,152 \]
\[ D_5 = \frac{2,880 - 1,152}{1.5} = 1,152^\dagger \]
\[ D_6 = \frac{1}{2} \left( \frac{1,152}{1.5} \right) = 576^\dagger \]

\(^\dagger\)Depreciation charges that will be used.

Note that in year 5 a switch was made to straight line depreciation and half a year in period 6.
3.3 Strategic Methodology

In the past American firms and stockholders put most of their emphasis on profit and cost control. That resulted in the lack of modernized facilities and equipment replacement. Because modernization and the purchase of new equipment tend in the short term to drive the organization profit down. This has created an atmosphere of “if it works, do not fix it”, make do with existing facilities and equipment. In reality, modernization and equipment replacement means that the organization is investing in its future. Often the firm’s survival depends on this. The list is endless of American firms that went out of business because they couldn’t compete in today’s global market. Their competitors invested in equipment and facilities, thus surviving and striving ahead. In the last decade it has been clear that organizations cannot devote all their attention to cost control alone, but rather an equal emphasis must be placed on quality. Today, other factors are emerging that will need the attention of the organization. These include controlling overhead, time, and managing information.

The proponents of strategic methodologies argue that financial justification methods are short-term (tactical) approaches only interested in cost reduction and not in the revenue-generating part of the equation. Strategic methodologies are long-term approaches that are interested in the long term standing of the firm, interested in increasing the organization's competitive edge and ensuring its future survival. Factors that are often referred to as benefits or opportunities, such as better quality, more accurate information, better service, customer satisfaction, and so on. These
opportunities are more of concern in the strategic process than the short term cost reduction. The bottom line is staying ahead of the competitors. These opportunities are subjective and are part of the art of management rather than the science of management. But subjective or not, the argument is that these opportunities have great effects on the organization and its prosperity.

Cost plays an important part in the survival of the organization. However, there is a vast difference between low cost and competitive cost. The cost structure must be competitive, as position is always important. Low-cost emphasis may not be effective. The company may disregard other product attributes such as quality or service in pursuing low cost, resulting in poor customer perception of its product or service.

3.3.1 Global Competition

No firm can ignore the transformation of the market into a global, competitive arena. There are sobering positive aspects to global competition—opportunities that are too large to be overlooked or ignored. Firms cannot ignore domestic or foreign competition. Competitiveness is a moving target. Thus a competitive firm must have ongoing strategies and programs to stay ahead of its competitors. Pragmatic responses to the global environment must blend offensive and defensive strategies. The organization must formulate offensive strategies when entering a foreign market and defensive when a foreign or domestic intrusion is seeking the same market. To be globally competitive in the coming decade, there is a need to create as broad a management
organization and customer base as possible. In order to advance this long term agenda the organization must have new customers, technology, innovation and adoption, and service. The firm must be constantly trying to interpret customers’ needs and develop respective products and services for those needs. A globally competitive firm must identify opportunities where technology will provide a strategic advantage, such as a new production technique or a new process. A good service may advance the firm’s competitive position where a weak service may destroy the business.

It is critical to know the principle domestic and international competitors. This can help the company to clearly define the market served, and market share and size. Knowing the competitor position and strategic options is very important. Such information or analysis can provide clues for short term operations improvement, readjustment, and long-term positioning. The company can compare itself to its principal competitors on the basis of the following factors:

- Financial power and clout.
- Technologies, automation, flexibility, processes, and production techniques.
- Management depth and experience in the global market, management adaptation and skills.
- Logistic and distribution resources, channels, and services.
- Brand recognition.
- Overall competitive strategy.

Competitive analysis can ensure that critical decisions are
rooted in deep understanding of the competitors. Specific areas of interest must be isolated and identified, then hypotheses developed on those areas. Then information is gathered to confirm or disprove the situation.

3.3.2 Formulating a Technological Manufacturing Plan

In today's global competitive market it has become increasingly clear that manufacturing must be used as a competitive weapon. A strategic manufacturing plan must be created in support of overall business goals and a competitive strategy. This will promote manufacturing excellence and contribute to the overall business success and prosperity. The business's competitive strategy might be, for example, to become a world class manufacturer, low cost producer and provider, or produce high quality products or all of these. The overall business plan will provide strategic direction for the company, but it does not provide specific or adequate direction for the creation of specific manufacturing programs. Manufacturing objectives should be derived from the overall business plan and competitive strategy and must create tactical programs based upon tangible and measurable objectives in the pursuit of improved cost, quality, and delivery. The following steps should be considered when formulating a technological manufacturing plan.

1. Stating and defining operating requirements. This is based on understanding the overall business plan. It is essential to the formulation of a technological plan since it creates the foundation
of the rest of the technological manufacturing strategy plan. It must stress business goals, issues, policies, manufacturing priorities and contingencies, manufacturing baselines, objectives, and measures. Before formulating the technological manufacturing plan, senior management must set the business goals, issues and policies. They should be defined in the overall business plan, and in the marketing, financial, and product plans. Priorities and constraints set the guidelines for the development of the manufacturing concepts and improvement programs. Examination of correct performance baselines, objectives, and measures provides an understanding of the present manufacturing environment. The firm must know its relative strengths in key technologies and make a realistic assessment of its ability to keep up with technological changes.

2. Objective Analysis. Objective analysis consists of quantitative evaluation of manufacturing objectives, measures, flows, priorities, and constraints. The appropriate objectives are defined, performance measures are determined, flows analyzed, priorities are set, and constraints noted. This analysis provides a basis for goals of future operating environments. Aggressive but relative objectives for performance in areas such as inventory turns, span time, cost, and quality will guide improvement in these areas. The analysis of material, process, and information flows assists in determining opportunities for improvement that will lead to achievement of the stated objectives.

3. Manufacturing concepts. Operational, organizational, equipment, product, facilities, and information system concepts are defined. Distinct technologies and subtechnologies are identified in the value chain. All the technologies and subtechnologies, no matter
how mundane, that are employed either by the firm or by its competitors must be identified. Potentially relevant technologies in other industries or under scientific development must be identified and investigated.

4. Determine which technologies and potential technological changes are most significant for competitive advantage and industry structure. Not all the technologies in the value chain will have significance for competition. The organization must isolate and identify these technologies and understand how they will affect cost, differentiation, or industry structure.

5. Select a technology strategy that will encompass all important technologies that reinforce the firm's overall competitive strategy.

3.3.3 Justification Process

Often justifying and implementing a new program or project remains an intuitive and often emotional process, even though the analysis may be based on a sound method. Many proposals are often accepted only due to external or internal events. That is, the proposal is accepted after the situation is out of control. Organizations have to change their ways. A clearly defined and planned justifying process must be put into action. Failures and obstacles to selling new ideas and programs must be overcome.

In many organizations the proposer (Industrial/or Manufacturing Engineer) is far removed from the approver (Board of Directors or Chief Executive) by a long chain of command involved in processing the proposal. See Figure 3.3. In some cases the approver's lack of functional knowledge makes the proposal hard to
Figure 3.3. The justification process within the organization.
evaluate, especially when his or her only exposure is a written report. A communication process must be planned. This communication process should go up and down the chain of command, with downward communication of strategic goals and direction and upward communication of operational capability. Investments and programs must reinforce or contribute to the strategic direction of the organization at every level of the value activities. When the communications fail, the result is frequently a strategy that cannot be executed under the current structure of operations, or operations improvement or proposals that are mismatched with regard to the strategic direction of the organization.

Another failure in the process is the way proposals are documented and presented. Often those who sell their proposals to top management lack skill in the arts of persuasion. Structural changes must occur within an organization to ensure a better justification process that can lead to better proposals and hence greater competitiveness. A steering committee should be formed to review the progress of analyses and the justification of new programs. Typically, the steering committee should consist of functional representatives of engineering, finance, manufacturing, and procurement who report directly to the company CEO. The steering committee addresses the organization and communication failures that were mentioned earlier. It brings the proposer or analyst closer to the policy-maker (approver), shrinking the gap of the chain of command between them and ensuring a harmonious process of communication toward a common goal or competitive direction.

Proposals must be justified not only on the basis of financial
factors, but also on other strategic factors—to match competitive moves and improve performance measures other than costs. Whether the proposal is major (a new system) or minor (a new machine), justification must include non-monetary parameters. There is always more than one alternative. No alternative is a “must” for the firm’s survival or prosperity. All alternatives must be investigated and analyzed, so that a preferred alternative can be selected.

The analyst must do his/her homework, for technical accuracy is important. Accurate numbers (through documentation) and excellent analysis are the bedrock of a good proposal. Understanding the benefits, the proposal should contribute to competitive success by providing a new capability, and/or leading to cost reduction. It is important to classify the benefits of each proposal. A clear understanding of the company’s competitive position, strategic direction, and the project’s potential contribution to them, as well as the impact of the project will have on the cost of the operation, are keys to success. As the project develops, progress should be documented and reported to a senior level steering committee, if there is one. There should be no surprises for those who review the proposal and who will ultimately recommend or approve it. It is important to early identify those who support the project and those who don’t. The analyst must understand both sides of the argument, for this can lead to a better and more complete written or oral package.
3.3.4 Multiple-Criteria Decision Making

Multiple criteria/attribute decision refers to making decisions in the presence of multiple criteria. These criteria are usually conflicting. All problems essentially have or share the following characteristics:

- **Multiple Objectives/Attributes.** Each problem has multiple objectives or attributes. The decision maker must generate objectives or attributes for each problem setting.
- **Conflict Among Criteria.** Criteria usually conflict with each other. For example, in the selection of a corporate strategy; the objective of a lower payback period might reduce the objective of a long life due to higher payback in later years.
- **Different Units.** Each objective or attribute may have a different unit of measurement. For example, payback period in years, productivity in units of production per unit of time. The developed software package, Justifying Automation And New Technologies (JANT) handles this problem very easily because the user rates the attributes qualitatively on the same scale.
- **Design/Selection.** The best alternative(preferred) is selected. That is, the most attractive over all criteria is best.

There are several multiple criteria decision methods that can be used to reach a decision. The author has chosen the simple additive weighting method (SAW), which is probably the best known and the most widely used method of multiple attribute decision making. It is easy to use and code, it is defined mathematically as follows:
Chapter 4
SYSTEM DESIGN AND SOFTWARE DESCRIPTION

4.1 System Design

A system is designed from the top down or in a structured fashion. The goals are defined, then the means to achieve these goals and the action necessary to implement these means are clearly defined. The system is first designed, then subdivided into manageable components or subroutines for development.

The proposed package was divided into several subroutines in order to maintain the modularity of the software. Each subroutine was developed, debugged, and tested separately. When the author was fully satisfied with the performance of the module (subroutine) it was integrated into the main program and tested once again to ensure a complete and accurate performance of the software. This approach ensures and improves the adaptability of the program. The programmer has more control over the design process. Changes do not alter the whole structure of the package. It is easy to incorporate or remove subroutines without altering other basic structures of the software. The design and testing process is simpler and easier. This process will ensure and provide a complete and well designed software package that meets its specifications and requirements.
4.1.1 Requirements

Before the detailed design of the software system, the author stated and defined several requirements or criteria that the package must possess or accomplish. The design criteria for the software package include, but are not limited to the following specifications:

- General Purpose.
The objective is to design a general purpose algorithm that can be used as a tool to aid the evaluator in the justification process.
- Capacity.
The package must have adequate capacity and memory. It must provide feedback to the user when the capacity is exceeded.
- User-Friendliness.
The software package must be very user-friendly and interactive, allowing the user to have full control during evaluation.
- Flexibility.
The software must allow the user to continue or stop evaluation at certain control points, and to have the opportunity to review output and make any necessary changes.
- Short Learning Curve.
The user is expected to become very quickly familiar with the operation and evaluation process. This is made easier by providing menus for the user to select from and feedback during an evaluation session.
- Editing.
The software must reject improper input of data, such as a negative number for the life of a project or a number that exceeds the...
package capacity, etc. The user must be prompted when improper data is entered and a course of action must be suggested.

- Modular.

The software package is to be developed in modules. Each module (subroutine) is to be designed, evaluated, debugged, and tested separately, then integrated into the package. After integration, the added module and the package are tested once again to make sure that the package is functioning correctly and according to its requirements.

4.1.2 Programming Language

It was mentioned in Chapter One that the author intended to use a structured programming language such as FORTRAN, C, TRUE BASIC, etc. The package is designed to run on an IBM-PC or any compatible computer that uses a DOS system. While the author is familiar with several structured languages, a decision was made to select TRUE BASIC for several reasons. True Basic provides quick and interactive responses and contains an efficient screen editor. It is a simple, but highly structured language with a quick compiler. Syntax errors are detected in all lines of a program and identified before a program runs. Compiled programs are condensed, eliminating comments and spaces, therefore taking less memory space on the disk.
4.2 Description of Programs

The package consists of a main program (MAIN) and twelve subroutines. The main program is a collection of menus for the user to choose from. It integrates the package into a single system. See figure 4.1. The user enters the system by inputting the name of the package (JANT) which stands for Justifying Automation And New technologies, and then striking the return key. After 20 to 40 seconds the name of the package, author, copyright and date, etc. will be displayed on the screen for five seconds. Then the MAIN program will display a menu on the screen for the user to choose from. The menu has the following options:

1 - Strategic Evaluation
2 - Financial Evaluation
3 - Tables
4 - Exit

Option exit (4) will return the user to the DOS system, thus ending the evaluation process. Option Table (3) will call subroutine FTABLE (factors table). The user can use this routine to determine compounding interest factors for any given interest and period of time. Financial selection (2) will allow the user to perform several financial analyses. After this option is chosen, the following menu of financial methods will appear on the screen:

1 - Discounted Cash Flows
2 - Payback Period
Figure 4.1. Basic structure of the main program.
3 - Capital Recovery/or Project Balance
4 - Exit

Option exit (4) will return the user to the first (previous) menu. Option capital recovery/or Project balance (3) will allow the user to perform financial analysis through both methods. A menu will be displayed for the user to choose from; the menu is as follows:

1 - Capital Recovery
2 - Project Balance

After the user has selected a method and performed the analysis, the program returns to the previous menu (financial methods menu). Option payback (2) will call the PAYBACK period subroutine, and the following menu will appear:

1 - Payback Period (no interest)
2 - Payback Period (with interest)

The user has the option of choosing one of the two methods. After the analysis is completed the program will return to the previous menu (financial methods menu). Option discounted cash flows (1) will call NETPV (net present value), and IRR subroutines. The user can choose one of the following methods in the menu:

1 - Net Present Worth
2 - Internal Rate of Return

Once again, after the user makes a choice and performs an analysis,
the program returns to the previous menu (financial methods menu).

Tracking back to the first menu, if the option strategic (1) was made, then the main program calls subroutine STRATEGI. This routine allows the user to evaluate up to one hundred alternatives based on financial analysis (payback period, net present value, internal rate of return, and so on) and non-monetary features (quality, customer service, competitive strategy etc.). After evaluating a number of alternatives, the program returns to the first menu.

There are some additional features in the software package which are commonly used. They are summarized as follows:
- When any option is selected, a message will be displayed on the screen identifying the option that was chosen and ask whether the user wants to continue or return to the previous menu.
- Once the user makes the decision to continue, a message will be displayed identifying the method of analysis. The user is asked to strike any key to continue.
- The user has the option of printing out the results after any analysis before returning to the previous menu.
- When a string is entered instead of a number, the user is prompted and asked to enter a number and vice versa.

4.2.1 Subroutine STRATEGI

This subroutine allows the user to evaluate up to one hundred alternatives. First, the user specifies the number of attributes on which the alternatives will be evaluated. Then the user identifies each attribute by inputting it through the keyboard. The second step
is to assign a weight of importance to each attribute. The subroutine provides the user with a menu on the screen to select from, and the user can choose one of the following options:

1. Very Important
2. Important
3. Necessary
4. Can Be Helpful
5. Unimportant

The routine has an equivalent weight for each selection on the menu and will assign a weight for the selected option. The scale is as follow:

- Very Important = 1
- Important = .8
- Necessary = .6
- Can Be Helpful = .4
- Unimportant = .2

This weight is internally assigned after the user has entered and rated all the attributes. The weights are normalized (their sum equals one); for example, if the user entered three attributes—quality, labor saving, and the payback period—and rated these attributes as very important, necessary, and important, then the weights would be .8/1+.8+.6 = .417, .6/1+.8+.6 = .25, and .6/1+.8+.6 = .333, respectively. The sum of .417+.333+.250 is one. This process ensures consistency and keeps the alternatives scores under one.

The next step, the subroutine, prompts the user to enter the number of proposals or alternatives that are under consideration. Should the user enter a negative number or a number that exceeds
the capacity of the package the routine will display a message to enter the correct number. The same process occurs when the number of attributes are entered. After the alternatives are entered through the keyboard, a menu will appear on the screen for the user to rate each alternative in meeting a specific attribute. The menu contains the following:

1. Superior
2. Excellent
3. Good
4. Above Average
5. Average
6. Below Average
7. Poor

Once again each menu selection has an equivalent weight. The scale is as follows:

Superior = 1
Excellent = .9
Good = .8
Above Average = .7
Average = .6
Below Average = .5
Poor = .4

After the user rates all the alternatives on meeting all the attributes/criteria, the program will determine an overall score for each alternative. All the alternatives are displayed on the screen
Figure 4.2. An alternative matrix example.
with their respective scores. The user may print these results and then return to the main program. This process can be best demonstrated by the use of an example. Let's say we wanted to rate two alternatives on the attributes of quality, labor saving, and the payback period. The user rated alternative (A) as excellent in terms of quality, good on labor saving, and good on payback period. The ratings for alternative (B) were superior on quality, above average on labor saving, and below average on the payback period. The overall scores were .84 for alternative (A) and .78 for alternative (B), see Figure 4.2. Thus the scores suggest that alternative (A) should be more seriously investigated or considered for implementation.

4.2.2 Subroutine FTABLE

This subroutine can be called by the main program. It is provided as a supplementary routine which can be used by the user to determine the discrete compounding interest factors (tables). Basically this subroutine can be used by the evaluator when he/she is manually evaluating a proposal based on financial or engineering economy approaches. Thus instead of searching the tables for interest factors, the user enters the factor of interest, the number of periods, and the interest rate. The routine outputs the number of periods, the interest rate; and the equivalent table factor. The user has the options of printing the results, continuing, or returning to the main program. The routine then provides the user with a menu of factors to choose from; the menu is as follows:
1 - F/P (find F given P)
2 - P/F (find P given F)
3 - F/A (find F given A)
4 - A/F (find A given F)
5 - P/A (find P given A)
6 - A/P (find A given P)
7 - A/G (find A given G)
8 - P/G (find P given G)
9 - F/G (find F given G)
10 - Exit (return to main program)

where
F = future worth (compounded amount)
P = present worth
A = annual recovery (sinking fund)
G = uniform gradient series.

This subroutine has unlimited capacity, it is only limited by the computer capacity. That is, any interest rate or number of periods can be entered.

4.2.3 Subroutine NETPV

Subroutine NETPV determines the equivalent Net Present Value of the cash flows of an investment or a project. It is called by the main program when the user chooses financial evaluation models. The user inputs the number of periods (years) and the minimum attractive rate of return, or the hurdle rate. At this point the routine asks the user if the cash flows are available; if they are,
then the user will enter them through the keyboard. Otherwise, subroutine CASHFLOW is called to determine the cash flows and to return them to NETPV. NETPV outputs the number of periods, the hurdle rate, the cash flows, the net present value and the depreciation method. The user has the options of printing them or returning to the main program.

4.2.4 Subroutine IRR

This subroutine determines the Internal Rate of Return. IRR can call subroutine CASHFLOW when the user needs to determine the yearly cash flows. The user inputs the number of periods (years) of the useful life of the asset. If the user enters a negative number or a number that exceeds the capacity of 100 periods, then the routine displays a message for the user to enter the correct number of periods. The user can enter the cash flows through the keyboard, or can call subroutine CASHFLOW to determine the yearly cash flows. The user will be given feedback if any of the following situations has occurred:

if all the entered cash flows are positive or negative,
if multiple internal rates of return exist for this cash flow,
if a negative internal rate of return is found.

A message will output to the user indicating the situation that has been encountered and a suggestion to check the cash flows.

The subroutine then outputs the depreciation method that was used and the depreciation amounts when CASHFLOW is called, the number of years, the net cash flows, and the internal rate of return.
Figure 4.3. The bisection method search technique.

LLn - lower limit at iteration n
ULn - upper limit at iteration n
It may display other information such as salvage value, usage rate, etc. depending on the depreciation method. After the analysis is completed the user can print out the results and then return to the main program (first menu).

It was mentioned in Chapter 3 that the internal rate of return is determined through trial and error. The author chose a search method known as the Bisection Method which can estimate the internal rate of return.

Basically, the routine starts with the assumption that the internal rate of return lies midway between -1 to 10,000. This point is used to calculate the present worth. If the present worth is zero ± .00001 then the interest rate is found. Otherwise, if the present worth is negative, then this point becomes the lower limit, and if the present worth is positive, then this point becomes the upper limit. This process continues until an interest rate is found, see Figure 4.3.

4.2.5 Subroutine PAYBACK

This subroutine is called by the main program and has two primary functions: to determine the payback period without interest, and to determine the payback period with interest. After it is called by the main program the following menu will appear:

1 - Payback Period (no interest)
2 - Payback Period (with interest)

Option 1 determines the payback period without taking into account
4 - Based on Usage Depreciation
5 - MACRS (current IRS methods)

The routine will prompt the user if he or she has entered a selection that is not on the menu and will allow the input of the correct option.

4.2.9 Subroutine SLDEP

Subroutine SLDEP determines the depreciation of an asset through the straight line depreciation model. It is called by subroutine CASHFLOW and the user is asked to enter the estimated salvage value. If the user enters it as a negative number, the routine prompts the user to enter a positive number. The depreciations over the life of the project are determined and returned to subroutine CASHFLOW. Also this subroutine, returns the salvage value and the depreciation method to routine CASHFLOW.

4.2.10 Subroutine SYDDEP

This subroutine determines the depreciation of an asset over its useful life through the Sum of the Years Digits Depreciation model. CASHFLOW calls this routine and supplies the number of periods and the initial investment. The user is asked to enter the estimated salvage value. The routine only accepts positive salvage value and will prompt the user if a negative number is entered. The results are returned to routine CASHFLOW.
4.2.11 Subroutine DDDEP

Subroutine DDDEP determines the depreciation charges through the use of the Double Declining Depreciation model. It is called by subroutine CASHFLOW and is supplied the number of periods (life of the asset). The depreciation charges are determined and returned to subroutine CASHFLOW with the depreciation method.

4.2.12 Subroutine USEDEP

This subroutine is called by the CASHFLOW subroutine to determine the depreciation charges of an asset through the Usage Depreciation model. CASHFLOW supplies the number of periods and the initial investment. Subroutine USEDEP asks the user to input the estimated lifetime usage and the usage in each period. The routine will reject the input of negative numbers and prompt the user when a negative number is entered. The depreciation charges are determined and sent back to subroutine CASHFLOW.

4.2.13 Subroutine MACRS

This subroutine determines the depreciation charges based on The Tax Act Reform of 1986. It utilizes the current methods that are in use or are allowed to be used by the IRS. It is called subroutine CASHFLOW, and CASHFLOW will supply the number of periods and the initial investment. The following menu will be displayed on the screen:

1 - Straight Line Depreciation
2 - Declining Depreciation Switching to Straight Line Depreciation

Option 1 will determine the depreciation charges through the straight line depreciation without using the salvage value. Option 2 will determine the depreciation charges through the declining model; however, a switch to straight line depreciation occurs when the depreciation through the declining model is less than the depreciation through the straight line model. When option 2 is chosen, the routine determines both the straight line depreciation and the declining depreciation charges, compares them at each period, and switches to straight line when it becomes necessary.
Chapter 5
APPLICATION AND TESTING

In order to prove the validity of the methodologies and their coding, the results obtained from testing the software package (JANT) are compared with results already found in the literature. Examples are taken from the literature and solved on JANT then the results are compared to make sure that JANT is working properly.

The alternatives evaluation algorithm is basically modeled on the simple additive weight method. The rating are subjective depending mostly on the user understanding of his or her firm’s goals and strategic objectives. This makes it difficult to compare the obtained results.

Example 5.1

Canada 1986 evaluated two alternatives based on four non-monetary attributes see Figure 2.1, and Figure 2.2. The net present values of each alternative were given as 300 million and 350 million dollars respectively. Canada did not provide complete data on how these present values were obtained. This limited us from running the financial data through JANT to obtain a net present values. This example is evaluated using JANT, based on five attributes (including net present value). Basically, these rating were based on Canada’s rating, so that comparison can be performed between JANT and Canada’s results. For an example a rating of 10 by Canada was
entered as superior rating in JANT. This same procedure was used for all the ratings. Table 5.1 provides the qualitative input data through JANT. Table 5.2 provides the numerical ratings that were assigned by JANT to the attributes and alternatives. In Canada's example alternative one scored 82 points with a net present value of $300 millions, and alternative two scored 75 with a net present value of $350 millions. JANT overall scores are 81% and 77% respectively, see Table 5.3. Basically, JANT's results are very close to Canada's results, but JANT analysis included the net present value of each alternative. This example was also checked manually to make sure that the numbers are correct.

Table 5.1. JANT qualitative input rating of the attributes and alternatives.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Weight</th>
<th>Alt. One</th>
<th>Alt. Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIMs Tactical Aims</td>
<td>very important</td>
<td>above average</td>
<td>excellent</td>
</tr>
<tr>
<td>Riskiness, Lack of</td>
<td>important</td>
<td>good</td>
<td>average</td>
</tr>
<tr>
<td>Serviceability</td>
<td>necessary</td>
<td>superior</td>
<td>above average</td>
</tr>
<tr>
<td>Mgt/Eng's Effort</td>
<td>can be helpful</td>
<td>good</td>
<td>average</td>
</tr>
<tr>
<td>Net Present Worth</td>
<td>Important</td>
<td>good</td>
<td>excellent</td>
</tr>
</tbody>
</table>
Table 5.2. Numerical Rating assigned by JANT.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Weight</th>
<th>Normalized Weight</th>
<th>Alternatives Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alt.1</td>
</tr>
<tr>
<td>C1Ms Tactical Aims</td>
<td>1</td>
<td>.28</td>
<td>.7</td>
</tr>
<tr>
<td>Riskiness, Lack of</td>
<td>.8</td>
<td>.22</td>
<td>.8</td>
</tr>
<tr>
<td>Serviceability</td>
<td>.6</td>
<td>.17</td>
<td>1</td>
</tr>
<tr>
<td>Mgt/Eng's Effort</td>
<td>.4</td>
<td>.11</td>
<td>.8</td>
</tr>
<tr>
<td>Net Present Worth</td>
<td>.8</td>
<td>.22</td>
<td>.8</td>
</tr>
</tbody>
</table>

Table 5.3. JANT alternatives scores output.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONE</td>
<td>.81</td>
</tr>
<tr>
<td>TWO</td>
<td>.77</td>
</tr>
</tbody>
</table>

The following are financial examples that were taken from the literature to test JANT and compare its results with the results of the literature's examples. The cash flows for these examples were already known, thus entered through the keyboard.

Example 5.2

Net Present Value. From Stevens 1980, example 5.3, page 75.

The net present value was found to be $3096. The data was input through JANT and analyzed, the input data and results are tabulated in Table 5.4. The net present values are the same, thus we may conclude that JANT results are correct.
Table 5.4. JANT input and output results for example 5.2.

The Present Worth Method

The hurdle rate (MARR) is 10.00%
The Net Present Value (NPV) is $3096.27

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3007</td>
</tr>
<tr>
<td>2</td>
<td>$ 3007</td>
</tr>
<tr>
<td>3</td>
<td>$ 3007</td>
</tr>
<tr>
<td>4</td>
<td>$ 3007</td>
</tr>
<tr>
<td>5</td>
<td>$ 3007</td>
</tr>
<tr>
<td>6</td>
<td>$ 3007</td>
</tr>
</tbody>
</table>

Example 5.3

Internal Rate Of Return. From Thuesen and Fabrycky 1989, the example on page 168. The internal rate of return was found to be 12.8%. JANT results are tabulated in Table 5.5. The results are the same, if we round off to three digits.

Table 5.5. JANT input and output results for example 5.3.

The Internal Rate Of Return Method

Number of Periods = 5

The Internal Rate of Return (interest) is 12.76%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 1000</td>
</tr>
<tr>
<td>1</td>
<td>$- 800</td>
</tr>
<tr>
<td>2</td>
<td>$ 500</td>
</tr>
<tr>
<td>3</td>
<td>$ 500</td>
</tr>
<tr>
<td>4</td>
<td>$ 500</td>
</tr>
<tr>
<td>5</td>
<td>$ 1200</td>
</tr>
</tbody>
</table>
Example 5.4

Payback Period (without interest). From Stevens 1980, example 5.4, page 81. The pay back period was found as 3.14 years. JANT results are given in Table 5.6. The payback period is the same as the example.

Table 5.6. JANT input and output results for example 5.4.

Payback Method (without interest)

The Payback Period is 3.14

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$- 5000</td>
</tr>
<tr>
<td>2</td>
<td>$ 7000</td>
</tr>
<tr>
<td>3</td>
<td>$ 7000</td>
</tr>
<tr>
<td>4</td>
<td>$ 7000</td>
</tr>
<tr>
<td>5</td>
<td>$ 7000</td>
</tr>
<tr>
<td>6</td>
<td>$ 7000</td>
</tr>
<tr>
<td>7</td>
<td>$ 7000</td>
</tr>
</tbody>
</table>

Example 5.5

Payback Period (with interest). From Thuesen and Fabrycky 1989, the example on page 178. The payback period was calculated as 5 years. JANT results are summarized in Table 5.7. JANT found the payback period to be 4.93 years. In the example the payback period was rounded off to 5 years.
Table 5.7. JANT input and output results for example 5.5.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.93

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-1000</td>
</tr>
<tr>
<td>1</td>
<td>$500</td>
</tr>
<tr>
<td>2</td>
<td>$300</td>
</tr>
<tr>
<td>3</td>
<td>$200</td>
</tr>
<tr>
<td>4</td>
<td>$200</td>
</tr>
<tr>
<td>5</td>
<td>$200</td>
</tr>
<tr>
<td>6</td>
<td>$200</td>
</tr>
</tbody>
</table>

Example 5.6

Project Balance. From Thuesen and Fabrycky 1989, the example on page 183. The results of the example are given in table 5.7. JANT results are given in Table 5.8. Once again JANT results confirms its accuracy and the validity of its coding.

Table 5.7. Project balance results of example 5.6, from Thuesen and Fabrycky.

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-10,000</td>
</tr>
<tr>
<td>1</td>
<td>-11,000</td>
</tr>
<tr>
<td>2</td>
<td>-8,200</td>
</tr>
<tr>
<td>3</td>
<td>-1,840</td>
</tr>
<tr>
<td>4</td>
<td>3,792</td>
</tr>
<tr>
<td>5</td>
<td>7,550</td>
</tr>
</tbody>
</table>
Table 5.8. JANT input and output results of example 5.6.

Number of Periods = 5
For an Interest Rate of 20.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
<td>$10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$1000</td>
<td>$11000.00</td>
</tr>
<tr>
<td>2</td>
<td>$5000</td>
<td>$8200.00</td>
</tr>
<tr>
<td>3</td>
<td>$8000</td>
<td>$1840.00</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$3792.00</td>
</tr>
<tr>
<td>5</td>
<td>$3000</td>
<td>$7550.40</td>
</tr>
</tbody>
</table>

Example 5.7

Capital Recovery. From Thuesen and Fabrycky 1989, the example on page 182. The yearly capital recovery cost was found to be $1155. The same results were found by JANT, the are are given in Table 5.9.

Table 5.9. JANT input and output results of example 5.7.

Capital Recovery Method

<table>
<thead>
<tr>
<th>Number of Periods = 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Interest Rate is 10.00%</td>
</tr>
<tr>
<td>Initial Investment = $5000</td>
</tr>
<tr>
<td>Salvage Value = $1000</td>
</tr>
</tbody>
</table>

Capital Recovery is $1155.2 /period
It was mentioned earlier that the cash flows of the previous example were known and were entered through the keyboard. The validity of the depreciation methods and the routine that determines the yearly net cash flows were not tested. In the following examples the yearly cash flows were determined with the help of JANT. Each example tests the validity of a financial method and a depreciation model. Unfortunately there were not complete examples in the literature to test JANT, thus an example is provided to test it's validity.

Example 5.8
Given an initial investment of $10,000 and its a salvage value of $1,000 with an estimated life of 5 years, assuming that some capital is being borrowed and $100 per year is paid in interest, the yearly estimated inflows of the investment are $8,000 per year except for the first three years, and $6,000 for the remaining years. The yearly outflows are $3,000 for the first two years and $20,000 for the remaining years. The estimated lifetime production is 10,000 units and 3,000 units are produced in the first and second years, 2,000 are produced in the third year, and 1,000 units are produced in each of the remaining years. The income tax rate is 52%. Determine the net present value of the asset using the following depreciation models:

- straight line depreciation
- sum of the years-digit depreciation
- double declining depreciation
- based on usage depreciation
- MACRS (straight line and declining depreciation)
Table 5.10. JANT input data from example 5.8, and the output depreciation charges using the straight line depreciation model.

Using Straight Line Depreciation
Salvage Value = $1000
Number of periods = 5
Tax Rate = 52%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
</tbody>
</table>

Table 5.11. JANT input data from example 5.8, and the output depreciation charges using the sum of years-digit depreciation model.

Using Sum of Years Digit Depreciation
Salvage Value = $1000
Number of Periods = 5
Tax Rate = 52%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$3000.0</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2400.0</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1800.0</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1200.0</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$600.0</td>
</tr>
</tbody>
</table>
Table 5.13. JANT input data from example 5.8, and the output depreciation charges using the double declining depreciation model.

Using Double Declining Depreciation

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$4000.0</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2400.0</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1440.0</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$864.0</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$296.0</td>
</tr>
</tbody>
</table>

Table 5.14. JANT input data from example 5.8, and the output depreciation charges using based on usage depreciation model.

Based on Usage Depreciation

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
<th>Period Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2700.0</td>
<td>3000</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2700.0</td>
<td>3000</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1800.0</td>
<td>2000</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$900.0</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$900.0</td>
<td>1000</td>
</tr>
</tbody>
</table>
Table 5.15. JANT input data from example 5.8, and the output depreciation charges using MACRS straight line depreciation model.

Using (MACRS) Straight Line Depreciation
Number of Periods = 5
Tax Rate = 52%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0.0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$1000.0</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2000.0</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$2000.0</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$2000.0</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$2000.0</td>
</tr>
<tr>
<td>6</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$1000.0</td>
</tr>
</tbody>
</table>

Table 5.16. JANT input data from example 5.8, and the output depreciation charges using MACRS declining depreciation model.

Using (MACRS) Declining Switching to Straight Line Depreciation
Number of Periods = 5
Tax Rate = 52%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Inflows(+)</th>
<th>Outflows(-)</th>
<th>Interest on Borr. Money(-)</th>
<th>Depreciation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
<td>$10000</td>
<td>$0</td>
<td>$0.0</td>
</tr>
<tr>
<td>1</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$2000.0</td>
</tr>
<tr>
<td>2</td>
<td>$8000</td>
<td>$3000</td>
<td>$100</td>
<td>$3200.0</td>
</tr>
<tr>
<td>3</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1920.0</td>
</tr>
<tr>
<td>4</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1152.0</td>
</tr>
<tr>
<td>5</td>
<td>$6000</td>
<td>$2000</td>
<td>$100</td>
<td>$1152.0</td>
</tr>
<tr>
<td>6</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$576.0</td>
</tr>
</tbody>
</table>
Table 5.17. JANT output of the net present value and the yearly cash flows of example 5.8, straight line depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $193.19

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$3288</td>
</tr>
<tr>
<td>2</td>
<td>$3288</td>
</tr>
<tr>
<td>3</td>
<td>$2808</td>
</tr>
<tr>
<td>4</td>
<td>$2808</td>
</tr>
<tr>
<td>5</td>
<td>$2808</td>
</tr>
</tbody>
</table>

Table 5.18. JANT output of the net present value and the yearly cash flows of example 5.8, sum of years-digit depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $483.09

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$3912</td>
</tr>
<tr>
<td>2</td>
<td>$3600</td>
</tr>
<tr>
<td>3</td>
<td>$2808</td>
</tr>
<tr>
<td>4</td>
<td>$2496</td>
</tr>
<tr>
<td>5</td>
<td>$2184</td>
</tr>
</tbody>
</table>
Table 5.19. JANT output of the net present value and the yearly cash flows of example 5.8, double declining declining depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $633.69

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$4432</td>
</tr>
<tr>
<td>2</td>
<td>$3600</td>
</tr>
<tr>
<td>3</td>
<td>$2621</td>
</tr>
<tr>
<td>4</td>
<td>$2321</td>
</tr>
<tr>
<td>5</td>
<td>$2026</td>
</tr>
</tbody>
</table>

Table 5.20. JANT output of the net present value and the yearly cash flows of example 5.8, based on usage depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $453.76

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$3756</td>
</tr>
<tr>
<td>2</td>
<td>$3756</td>
</tr>
<tr>
<td>3</td>
<td>$2808</td>
</tr>
<tr>
<td>4</td>
<td>$2340</td>
</tr>
<tr>
<td>5</td>
<td>$2340</td>
</tr>
</tbody>
</table>
Table 5.21. JANT output of the net present value and the yearly cash flows of example 5.8, MACRS straight line depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $314.45

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 2872</td>
</tr>
<tr>
<td>2</td>
<td>$ 3392</td>
</tr>
<tr>
<td>3</td>
<td>$ 2912</td>
</tr>
<tr>
<td>4</td>
<td>$ 2912</td>
</tr>
<tr>
<td>5</td>
<td>$ 2912</td>
</tr>
<tr>
<td>6</td>
<td>$ 520</td>
</tr>
</tbody>
</table>

Table 5.22. JANT output of the net present value and the yearly cash flows of example 5.8, MACRS declining depreciation model.

The Present Worth Method

The hurdle rate (MARR) is 15.00%
The Net Present Value (NPV) is $644.43

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3392</td>
</tr>
<tr>
<td>2</td>
<td>$ 4016</td>
</tr>
<tr>
<td>3</td>
<td>$ 2870</td>
</tr>
<tr>
<td>4</td>
<td>$ 2471</td>
</tr>
<tr>
<td>5</td>
<td>$ 2471</td>
</tr>
<tr>
<td>6</td>
<td>$ 300</td>
</tr>
</tbody>
</table>

Example 5.9

Determine the internal rate of return using the same data as example 5.8
**Table 5.23.** JANT output of the internal rate of return and the yearly cash flows of example 5.9, using straight line depreciation model.

The Internal Rate Of Return Method  
Number of Periods = 5

The Internal Rate of Return (interest) is 15.84%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$  3288</td>
</tr>
<tr>
<td>2</td>
<td>$  3288</td>
</tr>
<tr>
<td>3</td>
<td>$  2808</td>
</tr>
<tr>
<td>4</td>
<td>$  2808</td>
</tr>
<tr>
<td>5</td>
<td>$  2808</td>
</tr>
</tbody>
</table>

**Table 5.24.** JANT output of the internal rate of return and the yearly cash flows of example 5.9, using sum of years-digit depreciation model.

The Internal Rate Of Return Method  
Number of Periods = 5

The Internal Rate of Return (interest) is 17.27%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$  3912</td>
</tr>
<tr>
<td>2</td>
<td>$  3600</td>
</tr>
<tr>
<td>3</td>
<td>$  2808</td>
</tr>
<tr>
<td>4</td>
<td>$  2496</td>
</tr>
<tr>
<td>5</td>
<td>$  2184</td>
</tr>
</tbody>
</table>
Table 5.25. JANT output of the internal rate of return and the yearly cash flows of example 5.9, using double declining depreciation model.

The Internal Rate Of Return Method
Number of Periods = 5

The Internal Rate of Return (interest) is 18.10%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$  4432</td>
</tr>
<tr>
<td>2</td>
<td>$  3600</td>
</tr>
<tr>
<td>3</td>
<td>$  2621</td>
</tr>
<tr>
<td>4</td>
<td>$  2321</td>
</tr>
<tr>
<td>5</td>
<td>$  2026</td>
</tr>
</tbody>
</table>

Table 5.26. JANT output of the internal rate of return and the yearly cash flows of example 5.9, using based on usage depreciation model.

The Internal Rate Of Return Method
Number of Periods = 5

The Internal Rate of Return (interest) is 17.11%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$  3756</td>
</tr>
<tr>
<td>2</td>
<td>$  3756</td>
</tr>
<tr>
<td>3</td>
<td>$  2808</td>
</tr>
<tr>
<td>4</td>
<td>$  2340</td>
</tr>
<tr>
<td>5</td>
<td>$  2340</td>
</tr>
</tbody>
</table>
Table 5.27. JANT output of the internal rate of return and the yearly cash flows of example 5.9, MACRS straight line depreciation model.

The Internal Rate Of Return Method
Number of Periods = 6

The Internal Rate of Return (interest) is 16.30%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-</td>
</tr>
<tr>
<td>0</td>
<td>10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 2872</td>
</tr>
<tr>
<td>2</td>
<td>$ 3392</td>
</tr>
<tr>
<td>3</td>
<td>$ 2912</td>
</tr>
<tr>
<td>4</td>
<td>$ 2912</td>
</tr>
<tr>
<td>5</td>
<td>$ 2912</td>
</tr>
<tr>
<td>6</td>
<td>$ 520</td>
</tr>
</tbody>
</table>

Table 5.28. JANT output of the internal rate of return and the yearly cash flows of example 5.9, MACRS declining depreciation model.

The Internal Rate Of Return Method
Number of Periods = 6

The Internal Rate of Return (interest) is 17.87%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-</td>
</tr>
<tr>
<td>0</td>
<td>10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3392</td>
</tr>
<tr>
<td>2</td>
<td>$ 4016</td>
</tr>
<tr>
<td>3</td>
<td>$ 2870</td>
</tr>
<tr>
<td>4</td>
<td>$ 2471</td>
</tr>
<tr>
<td>5</td>
<td>$ 2471</td>
</tr>
<tr>
<td>6</td>
<td>$ 300</td>
</tr>
</tbody>
</table>

Example 5.10
Determine the payback period without interest given the same data as example 5.8.
Table 5.29. JANT output of the payback period and the yearly cash flows of example 5.10, using straight line depreciation model.

Payback Method (without interest)

The Payback Period is 3.22

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$ 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3288</td>
</tr>
<tr>
<td>2</td>
<td>$ 3288</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
</tr>
<tr>
<td>4</td>
<td>$ 2808</td>
</tr>
<tr>
<td>5</td>
<td>$ 2808</td>
</tr>
</tbody>
</table>

Table 5.30. JANT output of the payback period and the yearly cash flows of example 5.10, using sum of years-digit depreciation model.

Payback Method (without interest)

The Payback Period is 2.89

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$ 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3912</td>
</tr>
<tr>
<td>2</td>
<td>$ 3600</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
</tr>
<tr>
<td>4</td>
<td>$ 2496</td>
</tr>
<tr>
<td>5</td>
<td>$ 2184</td>
</tr>
</tbody>
</table>
Table 5.31. JANT output of the payback period and the yearly cash flows of example 5.10, using double declining depreciation model.

Payback Method (without interest)

The Payback Period is \(2.75\)

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 $-</td>
<td>10000</td>
</tr>
<tr>
<td>1 $</td>
<td>4432</td>
</tr>
<tr>
<td>2 $</td>
<td>3600</td>
</tr>
<tr>
<td>3 $</td>
<td>2621</td>
</tr>
<tr>
<td>4 $</td>
<td>2321</td>
</tr>
<tr>
<td>5 $</td>
<td>2026</td>
</tr>
</tbody>
</table>

Table 5.32. JANT output of the payback and the yearly cash flows of example 5.10, using based on usage depreciation model.

Payback Method (without interest)

The Payback Period is \(2.89\)

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 $-</td>
<td>10000</td>
</tr>
<tr>
<td>1 $</td>
<td>3912</td>
</tr>
<tr>
<td>2 $</td>
<td>3600</td>
</tr>
<tr>
<td>3 $</td>
<td>2808</td>
</tr>
<tr>
<td>4 $</td>
<td>2496</td>
</tr>
<tr>
<td>5 $</td>
<td>2184</td>
</tr>
</tbody>
</table>
Table 5.33. JANT output of the payback period and the yearly cash flows of example 5.10, MACRS straight line depreciation model.

Payback Method (without interest)

The Payback Period is 3.28

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$2872</td>
</tr>
<tr>
<td>2</td>
<td>$3392</td>
</tr>
<tr>
<td>3</td>
<td>$2912</td>
</tr>
<tr>
<td>4</td>
<td>$2912</td>
</tr>
<tr>
<td>5</td>
<td>$520</td>
</tr>
<tr>
<td>6</td>
<td>$</td>
</tr>
</tbody>
</table>

Table 5.34. JANT output of the payback and the yearly cash flows of example 5.10, MACRS declining depreciation model.

Payback Method (without interest)

The Payback Period is 2.90

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$-10000</td>
</tr>
<tr>
<td>1</td>
<td>$3392</td>
</tr>
<tr>
<td>2</td>
<td>$4016</td>
</tr>
<tr>
<td>3</td>
<td>$2870</td>
</tr>
<tr>
<td>4</td>
<td>$2471</td>
</tr>
<tr>
<td>5</td>
<td>$2471</td>
</tr>
<tr>
<td>6</td>
<td>$300</td>
</tr>
</tbody>
</table>

Example 5.11

Determine the payback period (with interest) using the same data as example 5.8.
Table 5.35. JANT output of the payback period with interest and the yearly cash flows of example 5.11, using straight line depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.86

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3288</td>
</tr>
<tr>
<td>2</td>
<td>$ 3288</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
</tr>
<tr>
<td>4</td>
<td>$ 2808</td>
</tr>
<tr>
<td>5</td>
<td>$ 2808</td>
</tr>
</tbody>
</table>

Table 5.36. JANT output of the payback period with interest and the yearly cash flows of example 5.11, using sum of years-digit depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.56

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3912</td>
</tr>
<tr>
<td>2</td>
<td>$ 3600</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
</tr>
<tr>
<td>4</td>
<td>$ 2496</td>
</tr>
<tr>
<td>5</td>
<td>$ 2184</td>
</tr>
</tbody>
</table>
Table 5.37. JANT output of the payback period with interest and the yearly cash flows of example 5.11, using double declining depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.37

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 4432</td>
</tr>
<tr>
<td>2</td>
<td>$ 3600</td>
</tr>
<tr>
<td>3</td>
<td>$ 2621</td>
</tr>
<tr>
<td>4</td>
<td>$ 2321</td>
</tr>
<tr>
<td>5</td>
<td>$ 2026</td>
</tr>
</tbody>
</table>

Table 5.38. JANT output of the payback period with interest and the yearly cash flows of example 5.11, using based on usage depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.61

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3756</td>
</tr>
<tr>
<td>2</td>
<td>$ 3756</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
</tr>
<tr>
<td>4</td>
<td>$ 2340</td>
</tr>
<tr>
<td>5</td>
<td>$ 2340</td>
</tr>
</tbody>
</table>
Table 5.39. JANT output of the payback period with interest and the yearly cash flows of example 5.11, MACRS straight line depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.94

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 2872</td>
</tr>
<tr>
<td>2</td>
<td>$ 3392</td>
</tr>
<tr>
<td>3</td>
<td>$ 2912</td>
</tr>
<tr>
<td>4</td>
<td>$ 2912</td>
</tr>
<tr>
<td>5</td>
<td>$ 2912</td>
</tr>
<tr>
<td>6</td>
<td>$ 520</td>
</tr>
</tbody>
</table>

Table 5.40. JANT output of the payback period with interest and the yearly cash flows of example 5.11, MACRS declining depreciation model.

The Payback Period Method (with interest), Discounted

For a Hurdle Rate of 15.00%
The Payback Period is 4.58

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net cashflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
</tr>
<tr>
<td>1</td>
<td>$ 3392</td>
</tr>
<tr>
<td>2</td>
<td>$ 4016</td>
</tr>
<tr>
<td>3</td>
<td>$ 2870</td>
</tr>
<tr>
<td>4</td>
<td>$ 2471</td>
</tr>
<tr>
<td>5</td>
<td>$ 2471</td>
</tr>
<tr>
<td>6</td>
<td>$ 300</td>
</tr>
</tbody>
</table>

Example 5.12

Determine the yearly project balance using the same data as in example 5.8.
Table 5.41. JANT output of the yearly project balance and cash flows of example 5.12, using straight line depreciation model.

Number of Periods = 5
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 3288</td>
<td>$- 8212.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 3288</td>
<td>$- 6155.80</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
<td>$- 4271.17</td>
</tr>
<tr>
<td>4</td>
<td>$ 2808</td>
<td>$- 2103.85</td>
</tr>
<tr>
<td>5</td>
<td>$ 2808</td>
<td>$ 388.58</td>
</tr>
</tbody>
</table>

Table 5.42. JANT output of the yearly project balance cash flows of example 5.12, using sum of years-digit depreciation model.

Number of Periods = 5
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 3912</td>
<td>$- 7588.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 3600</td>
<td>$- 5126.20</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
<td>$- 3087.13</td>
</tr>
<tr>
<td>4</td>
<td>$ 2496</td>
<td>$- 1054.20</td>
</tr>
<tr>
<td>5</td>
<td>$ 2184</td>
<td>$ 971.67</td>
</tr>
</tbody>
</table>
Table 5.43. JANT output of the yearly project balance and cash flows of example 5.12, using double declining depreciation model.

Number of Periods = 5
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 4432</td>
<td>$ 7068.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 3600</td>
<td>$ 4528.20</td>
</tr>
<tr>
<td>3</td>
<td>$ 2621</td>
<td>$ 2586.63</td>
</tr>
<tr>
<td>4</td>
<td>$ 2321</td>
<td>$ 653.34</td>
</tr>
<tr>
<td>5</td>
<td>$ 2026</td>
<td>$ 1274.57</td>
</tr>
</tbody>
</table>

Table 5.44. JANT output of the yearly project balance and cash flows of example 5.8, using based on usage depreciation model.

Number of Periods = 5
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 3756</td>
<td>$ 7744.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 3756</td>
<td>$ 5149.60</td>
</tr>
<tr>
<td>3</td>
<td>$ 2808</td>
<td>$ 3114.04</td>
</tr>
<tr>
<td>4</td>
<td>$ 2340</td>
<td>$ 1241.15</td>
</tr>
<tr>
<td>5</td>
<td>$ 2340</td>
<td>$ 912.68</td>
</tr>
</tbody>
</table>
Table 5.45. JANT output of the yearly project balance cash flows of example 5.12, MACRS straight line depreciation model.

Number of Periods = 6
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 2872</td>
<td>$- 8628.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 3392</td>
<td>$- 6530.20</td>
</tr>
<tr>
<td>3</td>
<td>$ 2912</td>
<td>$- 4597.73</td>
</tr>
<tr>
<td>4</td>
<td>$ 2912</td>
<td>$- 2375.39</td>
</tr>
<tr>
<td>5</td>
<td>$ 2912</td>
<td>$ 180.30</td>
</tr>
<tr>
<td>6</td>
<td>$ 520</td>
<td>$ 727.35</td>
</tr>
</tbody>
</table>

Table 5.46. JANT output of the yearly project balance cash flows of example 5.12, MACRS declining depreciation model.

Number of Periods = 6
For an Interest Rate of 15.00%

<table>
<thead>
<tr>
<th>End of Year</th>
<th>Net Cashflows</th>
<th>Project Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$- 10000</td>
<td>$- 10000.00</td>
</tr>
<tr>
<td>1</td>
<td>$ 3392</td>
<td>$- 8108.00</td>
</tr>
<tr>
<td>2</td>
<td>$ 4016</td>
<td>$- 5308.20</td>
</tr>
<tr>
<td>3</td>
<td>$ 2870</td>
<td>$- 3234.03</td>
</tr>
<tr>
<td>4</td>
<td>$ 2471</td>
<td>$- 1248.09</td>
</tr>
<tr>
<td>5</td>
<td>$ 2471</td>
<td>$ 1035.73</td>
</tr>
<tr>
<td>6</td>
<td>$ 300</td>
<td>$ 1490.61</td>
</tr>
</tbody>
</table>
This study was aimed at developing a general purpose justification tool box (software) to aid engineers in the manufacturing industries. The developed package is user-friendly and interactive, satisfying its specifications.

It is clear that plant modernization and technology advancement is necessary for competitiveness. This translates to huge investment in automation and new technologies. However, new technologies and automation cannot be justified for automation's and expansion's sake. A strategic manufacturing plan must be formulated and put into action providing a guide and direction for the organization.

Justification is a management art and not a science. Many unforeseen future factors are involved. However, justification that is based on a sound method and on a strategic manufacturing plan is by far more scientific and superior to justification that is based on reaction to some internal or external event after the problem is out of control.

In this thesis, a methodology has been presented which can assist a decision maker in evaluating and selecting from strategic proposals/alternatives. It is based on strategic consideration the so-called "opportunity" benefits resulting from implementation and on financial consideration that can be quantified. It is a tool box and
not some magical answer, a tool to be used wisely by a knowledgeable evaluator who understands the firm’s goals and direction, and the advantages and limitations of this methodology. The evaluator must look at the total picture and identify alternatives and options. Appraise the competitors’ moves toward automation and evaluate the consequences of his or her organization not investing. A sufficiently long planning horizon should be selected. Most firms use less than five years; consider using 5 to 10 years and even more depending on the industry and the significance of the investment. Planning must occur high up in the organization with an interdisciplinary team (steering committee) to conduct research, evaluate alternatives, and recommend actions. Planning and eternal hope is the key to success and prosperity, in time new ideas and approaches can be accepted and may become the norm.

I recommend that this package be used as a teaching aid in an engineering economy class. Also, it can be sold to small firms to be used as a justification tool/aid.

The package was developed with a clear understanding that future modifications can/should be easily incorporated or integrated. Therefore making it easily possible for a future thesis or non-thesis candidate to continue with this research and make any necessary modification.
References


Huber, Robert F. "Justification Barrier To Competitive Manufacturing," *Production*, September 1985, pp. 46-51.


Appendix A
Diagrams of the Software Programs
Flowchart of MAIN program

1. Strategic
2. Financial
3. Table
4. Exit

(1) menu

Table

(2) menu

1. Discounted
2. Payback
3. Project Balance/Capital Recovery
4. Exit

(3) menu

1. PW
2. IRR

(1) menu

Strategic

1. Payback(no int)
2. Payback(int)

(2) menu

1. Capital Recovery
2. Project Balance

(3) menu

Available

yes

no

Enter Cashflows

Compute Results

Print?

Call Cashflow

Call Depreciation

Stop
Welcome to a strategic evaluation....

Input Number of Attributes (N)

Input Number of Proposals (K)

Identify Attributes

Rate Attribute

Identify Proposals

Rate Each Proposal

Compute Score

Print?

to Main Program
Flowchart of subroutine FTABLE

1. F/P (find F given P)
2. P/F (find P given F)
3. F/A (find F given A)
4. A/F (find A given F)
5. P/A (find P given A)
6. A/P (find A given P)
7. A/G (find A given G)
8. P/G (find P given G)
9. F/G (find F given G)
10. Exit

Input Choice(C)

IF C = 10
else

C ≥ 1 AND C ≤ 9

Input Number of Periods

no

Input Interest Rate

no

Positive

yes

Positive

yes

INT = INT * .01
A = (1 + INT)^N

Compute Chosen Factor

PRINT
Figure Flowchart of subroutine NETPV from MAIN

Start

Welcome to Net Present Value Evaluation

no

Hit any key

yes

Do you have the yearly cash flows?

? no

yes

Input Number of Periods

Input The Hurdle Rate

message

no

IF

yes

N>0 OR N<100

J = 1

Input CF(I-1)

J = J + 1

no

? J>N+1

yes

Input the Hurdle Rate

no

positive

Call CASHFLOW

yes

Compute Net Present Value

Print?

return to MAIN
Flowchart of subroutine IRR from MAIN

Start

Welcome to an Internal Rate of Return Evaluation

no

Hit any key

yes

Do you have the yearly cash flows?

no

Call CASHFLOW

yes

Input Number of Periods

message

no

IF N>0 OR N<100

yes

J = 1

Input CF(I-1)

J = J + 1

no

IF J>N+1

yes

check if cashflows are (all positive) or (all negative) or multiple rates

output Message?

yes

Compute IRR Using the Bisection Method.

Print?

return to MAIN
Welcome to payback period evaluation....

1. Pb (no int)
2. Pb (with int)

INPUT CF(I-1)
K = N+1

TCF = TCF + CF(K)
K = N+1 AND TCF < 0

WHILE TCF ≤ 0
    IF
        no
        K = K + 1
    yes
    a

b

INPUT HR

INPUT CF(I-1)

TCF = TCF + CF(K)
K = K + 1

WHILE TCF ≤ 0

continue next page
PRINT CASH FLOWS HAVE NEGATIVE PAYBACK PERIOD

TCF = 0

yes

PBP = k-3

TCF = 0

no

PBP = (k-2) - TCF/CF(K-1)

PBB = (k-2) - (TCF*(1+HR/100)^{(k-2)}/CF(K-1))

PRINT ?

to Main Program
Flowchart of subroutine PROJBAL

from MAIN

Start

Welcome to Project Balance Evaluation...

no

? Hit any key

yes

Enter Interest Rate

no

message

positive yes

cash flows

? no

no Call CASHFLOW

yes

Enter Number of Periods

no

message

positive (or exceed capacity)

yes

I = 1

Inout CF(I)

no I>N

yes

COMPUTE PROJECT BALANCE

PRINT?

return to MAIN
Welcome to Capital Recovery Evaluation...

Hit any key

Enter Estimated Life (years)

Enter Interest Rate

Enter Initial Investment

Enter Salvage Value

COMPUTE CAPITAL RECOVERY

PRINT?

return to MAIN
Flowchart of subroutine CASHFLOWS

Start

Welcome to Cash Flows Evaluation...

Hit any key

Enter Number of Periods

Enter Effective Tax Rate

IF T<0 OR T>100

Enter Initial Investment

Positive

Positive

Positive

I = 2

Enter Gross Inflow

Enter Gross Outflow

a

b
Enter Total Interest on Borrowed Money

Positive

no

yes

\( I = I + 1 \)

no

? \( I > N+1 \)

yes

CALL DEPMEN

Compute Cashflows

? Print

Return to Calling Routine
Flowchart of subroutine DEPMEN

from CASHFLOW

1- Straight Line Depreciation
2- Sum of Years-Digit Depreciation
3- Double Declining Depreciation
4- Based on Usage Depreciation
5- MACRS (current IRS methods)

menu

Enter Choice (k)

message

IF K<1 OR K>5

yes

no

return to CASHFLOW
Flowchart of subroutine SLDEP

from DEDMEN

Start

Enter Salvage Value

message

positive number

no

yes

\[ l = 2 \]

compute

\[ \text{DEPR}(l) = \frac{\text{INV-SALV}}{N} \]

\[ l = l + 1 \]

no

\[ l > N + 1 \]

yes

return to CASHFLOW
Flowchart of subroutine SYDDEP

from DEDMEN

Start

Enter Salvage Value

positive

yes

no

message

I = 2

compute

DEPR(I) = \(2^*(N-I+1)/N(N+1)(INV-SALV)\)

I = I + 1

? I > N + 1

no yes

return to CASHFLOW
Flowchart of subroutine DDDEP

from DEDMEN

Start

Enter Salvage Value

message positive

no yes

R = 2/N
TDEP = 0
I = 2

compute

DEPR(I) = (INV-SALV)/N
I = I + 1
TDEP = TDEP + DEPR(I)

? I>N+1

no yes

DEPR(N+1) = INV-SALV-TDEP

return to CASHFLOW
Flowchart of subroutine USEDEP

Start

Enter Salvage Value

no

positive

yes

Enter Estimated Lifetime Use

no

positive

yes

I = 2

Enter Use in Period(I)

no

positive

yes

I = I + 1

no

I > N+1

yes

J = 2

DEPR(J) = (INV-SALV)*PUSE(I)/USE

J = J + 1

no

J > N+1

yes

return to CASHFLOW

Flowchart of subroutine MACRS

Start

Tax Reform of 1986...

no any key yes

else

1- Straight Line (no salvage value)
2- Declining Balance Switching to SLD

(1) menu

(2)

You Have Chosen Straight Line Depreciation

You Have Chosen Declining Balance Depreciation

no continue

else continue

DEPR(1)=INV/2N

I = 2

compute

DEPR(I)=INV/N

I = I + 1

? I>N+1

yes

DEP(1)=(ALPHA*INV)/2N
SLDEP(1)=INV/2N
BV(1)=INV
TDD=DDEP(1)
TSDL=SLDE
I = 2

3 DEP(I) = (ALPHA*INV)/N

LDDEP(I)>=(ALPHA/N)*BV(I-1)-DDDEP(I-1)
SLDEP(I)=BV(I-1)-DDDEP(I-1)/N-I+1.5

DDDEP(I)< SLDEP(I)

continue on next page

continue on next page
I \cdot DDDEP(N+1) = SLDEP(N)/2

\text{return to CASHFLOW}
Appendix B
Program Listing
2. The main program contains menu of the proposed approaches.
3. Other subroutines are called from the main program, these
4. are available in different files on the disk. Thus the same
5. subroutine can be used over and over again by different
6. programs or subprograms.

10
11
12
13
15 LIBRARY "STRATEGI"
17 LIBRARY "TABLE"
22 LIBRARY "NETPV"
24 LIBRARY "PAYBACK"
25 LIBRARY "IRR"
26 LIBRARY "PROJBAL"
27 LIBRARY "CAPRECV"
30 CLEAR
31 SET BACK "BLUE"
32 SET COLOR "WHITE"
33
48
50 CLEAR
60 SET CURSOR 6,19
70 PRINT "Justifying Automation and New Technologies"
80 SET CURSOR 9,32
90 PRINT "Ohio University"
100 SET CURSOR 11,16
110 PRINT "Department of Industrial and Systems Engineering"
120 SET CURSOR 13,30
130 PRINT "Athens, Ohio 45701"
140 SET CURSOR 16,26
150 PRINT "Written By: Aziz A. Younes"
160 SET CURSOR 18,2

170 PRINT "Advisor: E. Ralph Sims P.E"
200 SET CURSOR 20,32
205 PRINT "August 1990"
206 SET CURSOR 21,15
208 PRINT "(C)Copyright Ohio University and Aziz Younes 1990"
210 PAUSE 5
220 CLEAR
225 SET BACK "BLUE"
226 SET COLOR "WHITE"
230 SET CURSOR 6,18
240 PRINT "*****************************************************************************"
250 SET CURSOR 7,18
260 PRINT "*
270 SET CURSOR 8,18
280 PRINT "* Please Enter Your Choice *
285 SET CURSOR 9,18
288 PRINT "*
290 SET CURSOR 10,18
300 PRINT "* 1 - Strategic Evaluation *
310 SET CURSOR 11,18
320 PRINT "*
330 SET CURSOR 12,18
335 PRINT "* 2 - Financial Evaluation *
336 SET CURSOR 13,18
338 PRINT "*
340 SET CURSOR 14,18
342 PRINT "* 3 - Table *
345 SET CURSOR 15,18
348 PRINT "*
350 SET CURSOR 16,18
355 PRINT "* 4 - Exit *
359 SET CURSOR 17,18
360 PRINT "*
SET CURSOR 18,18
PRINT "***************************************************************************"
SET CURSOR 20,26
INPUT CHOICE

IF CHOICE = 1 THEN
  CLEAR
  SET CURSOR 10,15
  PRINT "You Have Chosen Strategic Evaluation"
  SET CURSOR 12,15
  PRINT "Do You Want to Continue (y/n)?"
  SET CURSOR 20,20
  INPUT ANS1$
  IF ANS1$ = "y" OR ANS1$ = "Y" THEN
    CALL STRATEGI
    GOTO 220
  ELSEIF ANS1$ = "N" OR ANS1$ = "n" THEN
    GOTO 220
  ELSE
    SET CURSOR 22,10
    PRINT "Input (y/n)?"
    GOTO 389
  END IF
ELSEIF CHOICE = 2 THEN
  CLEAR
  SET CURSOR 10,15
  PRINT "You Have Chosen Financial Evaluation"
  SET CURSOR 12,15
  PRINT "Do You Want to Continue (y/n)?"
  SET CURSOR 20,20
  INPUT ANS2$
  IF ANS2$ = "y" OR ANS2$ = "Y" THEN
    GOTO 470
  ELSEIF ANS2$ = "n" OR ANS2$ = "n" THEN
    GOTO 220
  ELSE
417 SET CURSOR 22,6
418 PRINT "Input (y/n)?"
419 GOTO 410
420 END IF
422 ELSEIF CHOICE = 3 THEN
423 CLEAR

425 SET CURSOR 10,15
426 PRINT "You Have Chosen Interest Tables"
427 SET CURSOR 12,15
428 PRINT "Do You Want to Continue (y/n)?"
430 SET CURSOR 20,20
432 INPUT ANSS2$
434 IF ANSS2$ = "y" OR ANSS2$ = "Y" THEN
435 CALL FTABLE
436 GOTO 220
437 ELSEIF ANSS2$ = "n" OR ANSS2$ = "N" THEN
439 GOTO 220
440 ELSE
442 SET CURSOR 22,10
443 PRINT "Input (y/n)?"
444 GOTO 432
448 END IF
456 ELSEIF CHOICE = 4 THEN
458 GOTO 1500
460 ELSE
462 PRINT "Enter Correct Number",
464 GOTO 380
466 END IF
468
470 SET BACK "RED"
475 SET COLOR "WHITE"
480 CLEAR
490 SET CURSOR 3,18
495 PRINT "**************************************************"
500 SET CURSOR 4,18
505 PRINT "*"  "*
510 SET CURSOR 5,18
515 PRINT "*" Please Enter Your Choice  "*
520 SET CURSOR 6,18
525 PRINT "*"  "*
530 SET CURSOR 7,18
540 PRINT "*"  1 - Discounted Cash flows
550 SET CURSOR 8,18

560 PRINT "*"  "*
570 SET CURSOR 9,18
580 PRINT "*"  2 - Pay Back Period  "*
590 SET CURSOR 10,18
600 PRINT "*"  "*
605 SET CURSOR 11,18
610 PRINT "*"  3 - Capital Recovery/or  "*
620 SET CURSOR 12,18
625 PRINT "*" Project Balance  "*
630 SET CURSOR 13,18
632 PRINT "*"  "*
633 SET CURSOR 14,18
635 PRINT "*"  4 - Exit  "*
636 SET CURSOR 15,18
637 PRINT ""----------------------------------------------------------------"'
640 SET CURSOR 18,22
642 INPUT SELEC2
644 IF SELEC2 = 1 THEN
645 CLEAR
647 SET CURSOR 8,15
648 PRINT "You Have Chosen The Discounted Cash Flows Method"  
650 SET CURSOR 12,15
651 PRINT "Do You Want to Continue (y/n)?"  
652 SET CURSOR 15,20
654 INPUT ANS3$
655 IF ANS3$ = "y" OR ANS3$ = "Y" THEN  
658 GOTO 725
ELSEIF ANS3$ = "n" OR ANS3$ = "N" THEN
GOTO 480
ELSE
SET CURSOR 20,15
PRINT "Input (y/n)?"
GOTO 654
END IF
ELSEIF SELEC2 = 2 THEN
CLEAR
SET CURSOR 8,15
PRINT "You Have Chosen The Payback Period Method"
SET CURSOR 12,15
PRINT "Do You Want to Continue (y/n)?"
SET CURSOR 15,20
INPUT ANSX$
IF ANSX$ = "y" OR ANSX$ = "Y" THEN
CALL PAYBACK
GOTO 470
ELSEIF ANSX$ = "n" OR ANSX$ = "N" THEN
GOTO 480
ELSE
SET CURSOR 20,15
PRINT "Input (y/n)?"
GOTO 678
END IF
ELSEIF SELEC2 = 3 THEN
GOTO 1085
ELSEIF SELEC2 = 4 THEN
GOTO 220
ELSE
GOTO 480
END IF
CLEAR
726 SET BACK "BLUE"
730 SET CURSOR 5,18
745 PRINT "******************************************************************"
750 SET CURSOR 6,18
755 PRINT ""
760 SET CURSOR 7,18
785 PRINT "* Please Enter Your Choice of the *"  
790 SET CURSOR 8,18
795 PRINT "*"
800 SET CURSOR 9,18
810 PRINT "* Discounted Cash flows *"
820 SET CURSOR 10,18
830 PRINT "*"
840 SET CURSOR 11,18
850 PRINT "* 1 - Present Worth *"
860 SET CURSOR 12,18
870 PRINT "*"
875 SET CURSOR 13,18
880 PRINT "* 2 - Internal Rate of Return *"
890 SET CURSOR 14,18
900 PRINT "*"
910 SET CURSOR 15,18
920 PRINT "******************************************************************"
940 SET CURSOR 20,21
942 INPUT SELEC4
944 IF SELEC4 = 1 THEN
945 CLEAR
947 SET CURSOR 8,15
948 PRINT "You Have Chosen The Net Present Value Method"
950 SET CURSOR 12,15
951 PRINT "Do You Want to Continue (y/n)?"
952 SET CURSOR 20,20
954 INPUT ANS4$ 
955 IF ANS4$ = "y" OR ANS4$ = "Y" THEN
958 CALL NETPV
959      GOTO 480
960      ELSEIF ANS4$ = "n" OR ANS4$ = "N" THEN
962      GOTO 725
963      ELSE
965      SET CURSOR 22,10
966      PRINT "Input (y/n)?"
967      GOTO 954
968      END IF
970      ELSEIF SELEC4 = 2 THEN
975      CLEAR
977      SET CURSOR 8,15
978      PRINT "You Have Chosen The Internal Rate of Return Method"
980      SET CURSOR 12,15
986      PRINT "Do You Want to Continue (y/n)?"

990      SET CURSOR 20,20
995      INPUT ANS5$
1000     IF ANS5$ = "y" OR ANS5$ = "Y" THEN
1010     CALL IRR
1020     ELSEIF ANS5$ = "n" OR ANS5$ = "n" THEN
1030     GOTO 725
1031     ELSE
1032     SET CURSOR 22,10
1033     PRINT "INPUT (y/n)?"
1034     GOTO 995
1035     END IF
1039     ELSE
1040     SET CURSOR 10,20
1050     PRINT "Input Correct Choice"
1055     GOTO 725
1060     END IF
1060     GOTO 480
1065     CLEAR
1086     SET CURSOR 10,18
1087     PRINT "You Have Chosen Project Balance/or Capital Recovery"
1088     SET CURSOR 12,20
1089 PRINT "Do You Want to Continue (y/n)?"
1090
1091 SET CURSOR 15,20
1092 INPUT AN$
1093   IF AN$ = "y" OR AN$ = "Y" THEN
1094   GOTO 1105
1096   ELSEIF AN$ = "n" OR AN$ = "N" THEN
1097   GOTO 480
1098   ELSE
1099   SET CURSOR 20,15
1100   PRINT "Input (y/n)?"
1101   GOTO 1092
1102   END IF
1105 CLEAR
1107 SET CURSOR 10,18
1108 PRINT "***************************************************************************"

1110 SET CURSOR 11,18
1120 PRINT "*
1130 SET CURSOR 12,18
1140 PRINT "* 1 - Capital Recovery
1145 SET CURSOR 13,18
1150 PRINT "*
1160 SET CURSOR 14,18
1165 PRINT "* 2 - Project Balance
1170 SET CURSOR 15,18
1180 PRINT "*
1190 SET CURSOR 16,18
1200 PRINT "***************************************************************************"
1210 SET CURSOR 18,22
1220 INPUT ONE
1225 CLEAR
1230 IF ONE = 1 THEN
1232   SET CURSOR 6,18
1235   PRINT "You Have Chosen Capital Recovery, Continue (y/n)?"
1240   SET CURSOR 8,20
1245  INPUT RES$
1250  IF RES$ = "N" OR RES$ = "n" THEN
1260    GOTO 1105
1265  ELSEIF RES$ = "Y" OR RES$ = "y" THEN
1268    CALL CAPRECv
1270    GOTO 480
1280  ELSE
1285    SET CURSOR 21,6
1290    PRINT "Input (y/n)?"
1295    GOTO 1245
1300  END IF
1310
1320  ELSEIF ONE = 2 THEN
1330    CLEAR
1332    SET CURSOR 6,18
1335    PRINT "You Have Chosen Project Balance, Continue (y/n)?"
1340    SET CURSOR 8,20
1345    INPUT RES$
1350  IF RES$ = "N" OR RES$ = "n" THEN
1360    GOTO 1105
1365  ELSEIF RES$ = "Y" OR RES$ = "y" THEN
1370    CALL PROJBAL
1375    GOTO 480
1380  ELSE
1385    SET CURSOR 20,6
1390    PRINT "Input (y/n)?"
1395    GOTO 1345
1400  END IF
1410  ELSE
1420    SET CURSOR 20,6
1430    PRINT "Enter the Correct Response"
1440    GOTO 1085
1450  END IF
1500  CLEAR
1510  END
This subroutine called "Strategi" will allow the user to evaluate up to 60 strategic alternatives, based on chosen attributes or features. The number of attributes can also be up to 60. The process is subjective based on the evaluator knowledge and preference.

Subroutine STRATEGI

EXTERNAL
SUB STRATEGI

CLEAR
SET CURSOR 10,15
PRINT "Welcome to a Strategic Evaluation Session."

SET CURSOR 24,10
PRINT "Hit Any Key to Continue?"

DO
IF KEY INPUT THEN
GET KEY Z
END IF
LOOP WHILE Z < 1

CLEAR
DIM K(100), ATT$(60), WEIGHT(100), ALT$(60), N(100), X(100,100) 60
CLEAR
SET CURSOR 10,10
PRINT "How Many Attributes are Under Consideration for Evaluation?"
SET CURSOR 15,20
90  INPUT NOSA
92  IF NOSA < 0 OR NOSA > 99 THEN
94    SET CURSOR 20,6
96    PRINT "Enter a positive number/or less than 100 attributes?"
98    GOTO 90
100  END IF
102
105  FOR I = 1 TO NOSA
110    CLEAR
120    SET CURSOR 10,15
130    PRINT "Input the Identity of Attribute ",I
135    SET CURSOR 15,20
140    INPUT ATTS$(I)
150    PAUSE 1
160    CLEAR
165  NEXT I
170
180  SET CURSOR 10,16
190  PRINT "Please Rate Each Attribute Based on"
200  SET CURSOR 12,16
210  PRINT "its Importance by Choosing One of the Following"
220  SET CURSOR 24,10
230  PRINT "Hit Any Key to Continue"
240  DO
260    IF KEY INPUT THEN
265      GET KEY S
270    END IF
280    LOOP WHILE S < 1
290    CLEAR
295    REM Rating The Strategic/or Importance of the Attributes
300  FOR I = 1 TO NOSA
310    SET CURSOR 2,10
320    PRINT "Input the Rating for the Attribute ",I;ATT$(I)
330    SET CURSOR 8,18
PRINT "Choose From the Following Menu"
SET CURSOR 10,20
PRINT "1 - Very Important"
SET CURSOR 11,20
PRINT "2 - Important"
SET CURSOR 12,20
PRINT "3 - Necessary"
SET CURSOR 13,20
PRINT "4 - Can be Helpful"
SET CURSOR 14,20
PRINT "5 - Unimportant"
SET CURSOR 20,22
INPUT CHOICE

IF CHOICE = 1 THEN
    LET WEIGHT(1) = 1.
ELSEIF CHOICE = 2 THEN
    LET WEIGHT(1) = .8
ELSEIF CHOICE = 3 THEN
    LET WEIGHT(1) = .6
ELSEIF CHOICE = 4 THEN
    LET WEIGHT(1) = .4
ELSEIF CHOICE = 5 THEN
    LET WEIGHT(1) = .2
ELSE
    PRINT "Enter Correct Choice ?"
GOTO 440
END IF
CLEAR
NEXT I
REM *********** Ratio Scale for the Attributes *****
LET TOTALWT = 0
FOR I = 1 TO NOSA
    LET TOTALWT = TOTALWT + WEIGHT(I)
NEXT I
605
610 FOR J = 1 TO NOSA
620 LET WEIGHT(J) = WEIGHT(J)/TOTALWT
630 NEXT J
635
640 REM **** Strategic Alternatives ****
650 SET CURSOR 10,10
660 PRINT "How Many Alternatives/Proposals Are Under Consideration"
665 SET CURSOR 15,15
670 INPUT NALT
672 IF NALT < 1 OR NALT > 99 THEN
674 SET CURSOR 20,6
675 PRINT "Enter a positive number/or less than 100 alternatives?"
677 GOTO 670
679 END IF
680
685 CLEAR
690 FOR I = 1 TO NALT
700 CLEAR
710 SET CURSOR 10,12
720 PRINT "Input the Identity of Alternative/Proposal ";I
730 SET CURSOR 12,22
740 INPUT ALT$(I)
750 PAUSE 1
760 CLEAR
770 NEXT I
780
790 REM **** RATING THE ALTERNATIVES ****
800 SET CURSOR 10,15
810 PRINT "Rate Each Alternative/Proposal with Respect to"
820 SET CURSOR 12,15
830 PRINT "Each of the Attributes From the List Below?"
840 SET CURSOR 24,10
850 PRINT "Hit Any Key to Continue?"
860 DO
870 IF KEY INPUT THEN
926   GET KEY SS
927   END IF
928   LOOP WHILE SS < 1
929   CLEAR
930   FOR J = 1 TO NALT
940   LET N(J) = 0
950   NEXT J
960
970   FOR I = 1 TO NOSA
980   FOR J = 1 TO NALT
990   SET CURSOR 2,3
1000  PRINT "Enter Rating of Proposal ... ";ALT$(J);"*** on Attribute...",ATT$(I)
1010  SET CURSOR 9,18
1020  PRINT "Choose From the Following Menu"
1030  SET CURSOR 11,20
1040  PRINT "1 - Superior"
1050  SET CURSOR 12,20
1060  PRINT "2 - Excellent"
1070  SET CURSOR 13,20
1080  PRINT "3 - Good"
1090  SET CURSOR 14,20
1100  PRINT "4 - Above Average"
1120  SET CURSOR 15,20
1135  PRINT "5 - Average"
1138  SET CURSOR 16,20
1140  PRINT "6 - Below Average"
1144  SET CURSOR 17,20

1146  PRINT "7 - Poor"
1147
1150  SET CURSOR 20,22
1155  INPUT SELEC
1160  PAUSE 1
1170
1180  IF SELEC = 1 THEN
1190 LET X(I,J) = 1
1200 ELSEIF SELEC = 2 THEN
1210 LET X(I,J) = .9
1220 ELSEIF SELEC = 3 THEN
1230 LET X(I,J) = .8
1240 ELSEIF SELEC = 4 THEN
1250 LET X(I,J) = .7
1260 ELSEIF SELEC = 5 THEN
1270 LET X(I,J) = .6
1280 ELSEIF SELEC = 6 THEN
1285 LET X(I,J) = .5
1288 ELSEIF SELEC = 7 THEN
1289 LET X(I,J) = .4
1292 ELSE
1295 PRINT "Enter Correct Choice?"
1300 GOTO 1150
1350 END IF
1360 CLEAR
1365 LET N(J) = N(J) + WEIGHT(I) * X(I,J)
1370 NEXT J
1375
1380 NEXT I
1390 SET CURSOR 2,2
1395 PRINT "ALTERNATIVE"
1400 SET CURSOR 2,60
1410 PRINT "TOTAL SCORE"
1420 FOR I = 1 TO NALT
1425 SET CURSOR 2*I+2,3
1430 PRINT ALT$(I)
1440 SET CURSOR 2*I+2,62
1450 PRINT USING "###.##":N(I);
1460 NEXT I
1480
1490 DO
1495 IF KEY INPUT THEN
5 ! This subroutine determines the net present value
6 (NPV) of an investment. It has the capability of
7 1 100 periods (years). The cash flows can be calculated
8 1 through cashflow subroutine or can be entered through
9 1 the key board.
10
11 Subroutine NETPV
12
13 EXTERNAL
14
15 SUB NETPV
16
17 LIBRARY "CASHFLOW"
18
19 DIM CF(100)
20 CLEAR
21 SET CURSOR 10,15
22 PRINT "welcome to the Net Present Value Evaluation...."
23 SET CURSOR 24,10
24 PRINT "Hit Any Key to Continue"
25
26 DO
27 IF KEY INPUT THEN
28 GET KEY S
130 END IF
135 LOOP WHILE $ < 1
138
140 CLEAR
150 SET CURSOR 10,15
155 PRINT "Do You Have the Yearly Cash Flows"
160 SET CURSOR 12,15
170 PRINT "Please Input (y/n)?"
175 SET CURSOR 15,15
177
180 INPUT ANS$
182 IF ANS$ = "N" OR ANS$ = "n" THEN
185 CLEAR
186 SET CURSOR 10,15
188 PRINT "Input the Hurdle Rate (Min. Attractive Rate)"
190 SET CURSOR 12,20
192 INPUT HR
194 IF HR < 0 THEN
196 SET CURSOR 21,6
198 PRINT "Enter a positive hurdle rate?"
200 GOTO 192
202 END IF
205 CALL CASHFLOW(CF,N)
210 GOTO 394
220 ELSE IF ANS$ = "Y" OR ANS$ = "y" THEN
258 CLEAR
270 SET CURSOR 10,15
280 PRINT "Input the Number of Periods (years)"
282 SET CURSOR 12,18
284 INPUT N
285 IF N < 0 OR N > 99 THEN
286 SET CURSOR 20,6
287 PRINT "Enter a positive number/or less than 100 periods?"
288 GOTO 284
290 END IF
293       CLEAR
294       FOR J = 1 TO N + 1
295       CLEAR
298       SET CURSOR 10,15
300       PRINT "Input the Net Cash Flows For End of Period",J-1
305       SET CURSOR 13,20
310       INPUT CF(J)
315       CLEAR
318       NEXT J
320       ELSE
325       SET CURSOR 20,15
330       PRINT "Input (y/n)?"
340       GOTO 180
345       END IF
350       CLEAR
355       SET CURSOR 10,15
365       PRINT "Input the Hurdle Rate (Min. Attractive Rate)"
370       SET CURSOR 12,20
375       INPUT HR
377       IF HR < 0 THEN
380       SET CURSOR 21,6
382       PRINT "Enter a positive hurdle rate?"
384       GOTO 375
386       END IF
390       CLEAR
394
395       LET HRR = HR/1
396       LET NPV = 0
397       FOR I = 1 TO N + 1
400       LET NPV = NPV + (CF(I))/(1 + HRR)^(I-1)
410       NEXT I
411       SET CURSOR 1,4
412       PRINT "The Present Worth Method"
415       SET CURSOR 4,4
418       PRINT USING "The hurdle rate (MARR) is ****%.HR;"
420       PRINT "%"
SET CURSOR 5,4
PRINT USING "The Net Present Value (NPV) is 
$~~~~~~~~~~~~~~~~~~$": NPV
SET CURSOR 7,4
PRINT "End of Year Net Cashflow"
SET CURSOR 8,4
PRINT "--------------------------
IF N <= 17 THEN
FOR I = 1 TO N+1
SET CURSOR I+8,8
PRINT USING "##
$~~~~~~~~~~~~~~~~~~$":I-1, CF(I)
NEXT I
ELSE
FOR I = 1 TO 17
SET CURSOR I+8,8
PRINT USING "##
$~~~~~~~~~~~~~~~~~~$":I-1, CF(I)
NEXT I
DO
IF KEY INPUT THEN
GET KEY Z
END IF
LOOP WHILE Z <> 13
LET Z = 0
FOR I = 18 TO N+1
SET CURSOR I-17,8
PRINT USING "##
$~~~~~~~~~~~~~~~~~~$":I-1, CF(I)
NEXT I
END IF
CLEAR
DO
IF KEY INPUT THEN
GET KEY SS
END IF
LOOP WHILE SS <> 13
**Subroutine IRR**

Subroutine IRR

EXTERNAL

SUB IRR

LIBRARY "CASHFLOW"

CLEAR

SET COLOR "WHITE"

SET BACK "BLUE"

DIM PV(110), CF(60), PW(100), X(1000)

LET ERROR = .00001

LET FLAG = 1

SET CURSOR 8,18

PRINT "Welcome to an internal rate of return evaluation....."

SET CURSOR 24,6

PRINT "Hit any key to continue?"

DO

IF KEY INPUT THEN

GET KEY S

END IF

LOOP WHILE S < 1

CLEAR
71 LET CURSOR 10,18
72 PRINT "Do You Have the Net Cashflows (y/n)?"
74 LET CURSOR 12,20
75 INPUT ANS$

76 IF ANS$ = "n" OR ANS$ = "N" THEN
77 CLEAR
78 CALL CASHFLOW(CF,N)
79 GOTO 155
80 ELSEIF ANS$ = "y" OR ANS$ = "Y" THEN
82 CLEAR
84 LET CURSOR 10,18
86 PRINT "Please Enter the Number of Periods (years)"
88 LET CURSOR 12,20
90 INPUT N
92 IF N < 0 OR N > 99 THEN
94 LET CURSOR 20,6
96 PRINT "Enter a positive or less than 100 periods"
98 GOTO 90
100 END IF
105
110 FOR I = 1 TO N+1
115 CLEAR
118 LET CURSOR 10,18
120 PRINT "Enter the Net Cashflows for Period (year)", I-1
125 LET CURSOR 12,20
130 INPUT CF(I)
135 CLEAR
140 NEXT I
142 ELSE
144 LET CURSOR 20,6
146 PRINT "Input (y/n)?"
148 GOTO 75
150 END IF
155 LET K = 0
158 DO
160 IF $k = (N+1)$ AND $CF(N+1) > 0$ THEN
162 CLEAR
164 SET CURSOR 2,4
166 PRINT "ALL POSITIVE CASHFLOWS (check)?"
168 EXIT DO
169 END IF

170 LET $k = k + 1$
172 LOOP WHILE $CF(k) > 0$
174
175 LET $kk = 0$
176 DO
178 IF $kk = (N+1)$ AND $CF(N+1) < 0$ THEN
180 CLEAR
181 SET CURSOR 2,4
182 PRINT "ALL NEGATIVE CASHFLOWS (check)?"
183 EXIT DO
184 END IF
185 LET $kk = kk + 1$
187 LOOP WHILE $CF(kk) < 0$
188
190 LET $up = 10000$
192 LET $down = -1$
194 LET $int = (up + down)/2$
196 LET $pw(1) = CF(1)$
198 FOR $j = 2$ TO $N+1$
200 LET $pw(j) =pw(j-1)+CF(j)/(1+int)^(j-1)$
202 NEXT $j$
205
208 IF ABS$(up-down) < ERROR$ THEN
210 GOTO 243
212 END IF
215 IF $pw(N+1) > 0$ THEN
218 LET $down = int$
220 GOTO 194
222 ELSEIF $pw(N+1) < 0$ THEN
225 LET UP = INT
230 GOTO 194
235 ELSE
240 242 END IF
243 IF INT < 0 THEN
244 SET CURSOR 1,4
245 PRINT "NEGATIVE INTEREST (check) CASHFLOWS"
246 END IF
247 248 SET CURSOR 3,4
249 PRINT USING "Number of Periods = ###";N
250 SET CURSOR 5,4
251 PRINT USING "The Internal Rate of Return (interest) is
*********** %.",INT*100;
252 PRINT "%"
254 SET CURSOR 7,4
260 PRINT "End of Year Net Cashflows"
270 SET CURSOR 8,4
280 PRINT "----------------- -----------------"
285 IF N <= 17 THEN
290 FOR I = 1 TO N+1
300 SET CURSOR I+8,6
310 PRINT USING "$**************":I- 1,CF(I)
320 NEXT I
325 ELSE
330 FOR I = 1 TO 17
335 SET CURSOR I+8,8
340 PRINT USING "$**************":I- 1,CF(I)
345 NEXT I
350 DO
355 IF KEY INPUT THEN
357 GET KE Z
354 END IF
355 LOOP WHILE Z <> 13
356 LET Z = 0
358 FOR I = 18 TO N+1
360 SET CURSOR I-17,8
365 PRINT USING "##
$**********:1- 1,CF(I)
370 NEXT I
375 END IF
378 CLEAR
380
382 DO
384 IF KEY INPUT THEN
386 GET KEY SS
388 END IF
390 LOOP WHILE SS <> 13
391 LET SS = 0
400 END SUB

3
|-----------------------------------------------------|
7 | This subroutine determines the payback period an   |
8 | investment. It has the capability of 100 periods     |
10 | (years). The cash flows can be calculated throughthe|
12 | cashflow subroutine or can be entered through the key|
15 | board.                                              |
17
19 |-----------------------------------------------------|
21 | Subroutine PAYBACK                                  |
23 |-----------------------------------------------------|
25
75 EXTERNAL
40
45 SUB PAYBACK
50
55 LIBRARY "CASHFLOW"
62  DIM CF(100)
65   CLEAR
66   SET BACK "BLUE"
70   SET CURSOR 10,15
80   PRINT "Welcome to the Payback Period Evaluation..." 90   SET CURSOR 24,10
90   PRINT "Hit Any Key to Continue"
100  DO
102  IF KEY INPUT THEN
105     GET KEY S
110     END IF
112   LOOP WHILE S < 1
113
115  CLEAR
118  SET CURSOR 8,18
120  PRINT "**********************************************************************************"
122  SET CURSOR 9,18
124  PRINT "***"
125  SET CURSOR 10,18
126  PRINT "*** Enter Your Selection ***"
128  SET CURSOR 11,18
130  PRINT "***"
132  SET CURSOR 12,18
134  PRINT "*** 1 - Payback (no interest) ***"
135  SET CURSOR 13,18
138  PRINT "*** 2 - Payback (with interest) ***"
140  SET CURSOR 14,18
150  PRINT "***"
152  SET CURSOR 15,18
154  PRINT "**********************************************************************************"
158  SET CURSOR 17,20
160  INPUT SELC
162  IF SELC = 1 THEN
164     GOTO 178
165  ELSE IF SELC = 2 THEN
166 GOTO 435
168 ELSE
169 SET CURSOR 20,15
170 PRINT "Input Correct Response"
172 GOTO 160
174 END IF
175
178 CLEAR
180 SET CURSOR 10,15
185 PRINT "Do You Have the Yearly Cash Flows"
190 SET CURSOR 12,15
195 PRINT "Please Input (y/n)?"
200 SET CURSOR 15,15
205 INPUT ANS$

210 IF ANS$ = "N" OR ANS$ = "n" THEN
215 CALL CASHFLOW(CF,N)
220 ELSEIF ANS$ = "Y" OR ANS$ = "y" THEN
230 CLEAR
235 SET CURSOR 10,15
240 PRINT "Input the Number of Periods (years)"
250 SET CURSOR 12,18
260 INPUT N
270 IF N <= 0 THEN
275 SET CURSOR 20,6
277 PRINT "Enter a positive number of the periods?"
280 GOTO 260
281 END IF
288
290 FOR J = 1 TO N + 1
295 CLEAR
298 SET CURSOR 10,15
300 PRINT "Input the Net Cash Flows For End of Period "; J-1
305 SET CURSOR 13,20
310 INPUT CF(J)
315 CLEAR
318  NEXT J
320  ELSE
325  SET CURSOR 20,15
330  PRINT "Input (y/n)?"
340  GOTO 205
345  END IF
350 
355  LET TCF = 0
360  LET K = 1
365  DO
370  LET TCF = TCF + CF(K)
381  IF K = N+1 AND TCF < 0 THEN
382  SET CURSOR 5,5
383  PRINT "NEGATIVE CASHFLOW, no Payback Period"
384  GOTO 726
385  END IF
386  LET K = K + 1
388  LOOP WHILE TCF <= 0
390  IF TCF = 0 THEN
395  LET PBP = K - 3
400  ELSE
410  LET PBP = (K - 2) - (TCF/CF(K-1))
420  END IF
422  SET CURSOR 2,4
424  PRINT "Payback Method (without interest)"
425  GOTO 660
430 
435  CLEAR
438  SET CURSOR 10,18
440  PRINT "Enter the Hurdle Rate (example 15)"
445  SET CURSOR 13,20
448  INPUT HR
450  IF HR < 0 THEN
452  SET CURSOR 20,6
454  PRINT "Enter a positive hurdle rate"
455    GOTO 450
458    END IF
459
460    CLEAR
462    SET CURSOR 10,15
465    PRINT "Do You Have the Yearly Cash Flows"
470    SET CURSOR 12,15
475    PRINT "Please Input (y/n)?"
480    SET CURSOR 15,15
485    INPUT ANS$
488    IF ANS$ = "N" OR ANS$ = "n" THEN
490    CALL CASHFLOW(CF,N)
500    ELSE IF ANS$ = "Y" OR ANS$ = "y" THEN
505    CLEAR
510    SET CURSOR 10,15
520    PRINT "Input the Number of Periods (years)"
525    SET CURSOR 12,18
526    INPUT N
528    IF N < 0 OR N > 99 THEN
530    SET CURSOR 20,6
531    PRINT "Enter a positive number of periods/or less than 100"
532    GOTO 526
534    END IF
535    CLEAR
540    FOR J = 1 TO N + 1
545    CLEAR
548    SET CURSOR 10,15
550    PRINT "Input the Net Cash Flows For End of Period ",J-1
552    SET CURSOR 13,20
555    INPUT CF(J)
558    CLEAR
560    NEXT J
565    ELSE
570    SET CURSOR 20,15
575    PRINT "Input (y/n)?"
578  GOTO 485
580  END IF
585
590  LET TCF = 0
595  LET K = 1
600  DO
605  LET TCF = TCF + CF(K)/(1+HR/100)^(K-1)
606  IF K = N+1 AND TCF < 0 THEN
608    SET CURSOR 5,5
609    PRINT "NEGATIVE CASHFLOW: no Payback Period"
611  GOTO 726
612  END IF
614  LET K = K + 1
615  LOOP WHILE TCF <= 0
618  IF TCF = 0 THEN
620    LET PBP = K - 3
625  ELSE
630    LET PBP = (K - 2) - (TCF*(1+HR/100)^(K-2))/CF(K-1)
635  END IF
640  SET CURSOR 2,4

645  PRINT "The Payback Period Method (with interest), Discounted"
650  SET CURSOR 4,4
655  PRINT USING "For a Hurdle Rate of ****.##": HR;
656  PRINT "%"
660
671
675  SET CURSOR 5,4
680  PRINT USING "The Payback Period is ****.##": PBP
681  SET CURSOR 7,4
682  PRINT "End of Year  Net cashflow"
684  SET CURSOR 8,4
688  PRINT "----------------  ---------------"
689  IF N <= 17 THEN
690    FOR I = 1 TO N+1
692      SET CURSOR 8+I,8
698 PRINT USING "## $..........................":I-1,CF(I)
700 NEXT I
702 ELSE
704 FOR I = 1 TO 17
705 SET CURSOR I+8,8
706 PRINT USING "## $..........................":I-1,CF(I)
708 NEXT I
709 DO
710 IF KEY INPUT THEN
712 GET KEY SS
713 END IF
714 LOOP WHILE SS <> 13
715 LET SS = 0
716 FOR I = 18 TO N+1
718 SET CURSOR I-17,8
720 PRINT USING "## $..........................":I-1,CF(I)
722 NEXT I
724 END IF
725 CLEAR
726 DO
727 IF KEY INPUT THEN
728 GET KEY Z
730 END IF
732 LOOP WHILE Z <> 13
733
735 END SUB

5  | This subroutine determines the project balance of an
6  | investment. It has the capability of 100 periods (years). The
7  | 101 cash flows can be calculated through JANT subroutine or
8  | can be entered through the key board.
EXTERNAL
SUB PROJBAL
LIBRARY "CASHFLOW"

DIM CF(100),PB(100),PBT(100)
CLEAR
SET CURSOR 10,15
PRINT "Welcome to a Project Balance Evaluation...."
SET CURSOR 24,10
PRINT "Hit Any Key to Continue"
DO
IF KEY INPUT THEN
GET KEY S
END IF
LOOP WHILE S < 1
CLEAR

SET CURSOR 10,18
PRINT "Enter the Interest Rate"

SET CURSOR 12,20
INPUT INT
IF INT < 0 THEN
SET CURSOR 20,6
PRINT "Enter a Positive Interest Rate?"
GOTO 190
END IF
CLEAR
SET CURSOR 10,18
PRINT "Do you have the cashflows (y/n)?"
SET CURSOR 12,20
290 INPUT ANS$
300 IF ANS$ = "Y" OR ANS$ = "y" THEN
310   CLEAR
320   SET CURSOR 10,18
330   PRINT "Input the Number of Periods (years), Life of the Project"
340   SET CURSOR 12,20
350 INPUT N
360 IF N <= 0 OR N > 99 THEN
370   SET CURSOR 20,6
380   PRINT "Enter a positive number of years/or less then 100?"
390   GOTO 350
400   END IF
410   CLEAR
420 FOR I = 1 TO N+1
430   SET CURSOR 10,18
440   PRINT "Input the Cashflow for Year", I-1
450   SET CURSOR 12,20
460 INPUT CF(I)
470   CLEAR
480 NEXT I
490
500 ELSEIF ANS$ = "N" OR ANS$ = "n" THEN
510   CALL CASHFLOW(CF,N)
520 ELSE
530   SET CURSOR 20,6
540   PRINT "Input (y/n)?"
550   GOTO 290
560   END IF
565
570 SET CURSOR 3,4
580 PRINT USING "Number of Periods = ###": N
590 SET CURSOR 4,4
592 PRINT USING "For an Interest Rate of ###.###", INT;
593 PRINT "%"
598 LET PB(1) = CF(1)
600 FOR I = 1 TO N+1
605 LET PB(I) = PB(I-1)*(1+INT(100)+CF(I))
610 NEXT I
615
660 SET CURSOR 7,4
662 PRINT "End of Year Net Cashflows"
663 PRINT "Project Balance"
665 SET CURSOR 8,4
668 PRINT "----------  ----------
---------- "
669 IF I <= 17 THEN
670 FOR I = 1 TO 17
675 SET CURSOR I+8,8
680 PRINT USING "###";
685 NEXT I
690 ELSE
700 FOR I = 1 TO 17
710 SET CURSOR I+8,8
715 PRINT USING "###";
720 NEXT I
725 DO
730 IF INPUT KEY THEN
735 GET KEY Z
740 END IF
750 LOOP WHILE Z <> 13
760 FOR I = 18 TO N+1
765 SET CURSOR I-17,N
770 PRINT USING "###";
775 NEXT I
782 END IF
760 DO
780 IF KEY INPUT THEN
790 GET KEY SS
800 END IF
810 LOOP WHILE SS <> 13
820 LET SS = 0
825
830 END SUB

5  |**************************************************************************|
7  |This subroutine determines the capital recovery of an investment. It has the capability of 100 periods. The cash flows can be calculated through cashflow subroutine or can be entered through the key board.
8  |**************************************************************************|
10  |**************************************************************************|
12  |Subroutine CAPRECV
14  |**************************************************************************|
15  |**************************************************************************|
17  |**************************************************************************|
19  |**************************************************************************|
21  |
23  |
25  |EXTERNAL
27  |SUB CAPRECV
30  |
32  |CLEAR
34  |SET CURSOR 10,15
36  |PRINT "Welcome to a Capital Recovery Evaluation...."
38  |SET CURSOR 24,10
40  |
42  |PRINT "Hit Any Key to Continue"
44  |DO
46  |IF KEY INPUT THEN
48  |GET KEY SS
50  |END IF
135 LOOP WHILE S < 1
140
255 CLEAR
270 SET CURSOR 10,18
280 PRINT "input the Number of Periods (years)"
282 SET CURSOR 12,20
284 INPUT N
290 IF N <= 0 THEN
295 SET CURSOR 20,6
300 PRINT "Enter a Positive Number of Years?"
305 GOTO 284
310 END IF
312
315 SET CURSOR 15,18
320 PRINT "Enter the Interest Rate (example: 15)"
325 SET CURSOR 17,20
330 INPUT INT
340 IF INT < 0 THEN
350 SET CURSOR 22,6
355 PRINT "Enter a Positive Interest Rate?"
360 GOTO 330
370 END IF
375
380 CLEAR
390 SET CURSOR 10,18
395 PRINT "Enter the initial investment"
398 SET CURSOR 12,20
400 INPUT INV
410 IF INV < 0 THEN
415 SET CURSOR 20,6
420 PRINT "Enter a Positive Investment?"
430 GOTO 400
440 END IF
445
450 SET CURSOR 15,18
455 PRINT "Enter the Salvage Value"
460 SET CURSOR 17,20
470 INPUT SALV
472 IF SALV < 0 THEN
475 SET CURSOR 20,6
477 PRINT "Enter a positive salvage value?"
478 GOTO 470
479 END IF
480
485 CLEAR
490 LET INT = INT/100
500 LET CR=((INV-SALV)*(((INT*(1+INT)*N)/(((1+INT)*N)-1)))+
(SALV*INT)
502 SET CURSOR 3,4
504 PRINT "Capital Recovery Method"
506 SET CURSOR 5,4
508 PRINT USING "Number of Periods = #":N
510 SET CURSOR 6,4
512 PRINT USING "The Interest Rate is ###.###":INT*100;
514 PRINT 
515 SET CURSOR 7,4
516 PRINT USING "Initial Investment = $###########":INV
517 SET CURSOR 8,4
519 PRINT USING "Salvage Value = $###########":SALV
520 SET CURSOR 12,4
521 PRINT USING "Capital Recovery is $########### / period":CR
522 DO
523 IF KEY INPUT THEN
524 GET KEY SS
526 END IF
530 LOOP WHILE SS <> 13
535 LET SS = 0
538
540 END SUB
This subroutine will figure out the tables for cashflows. The user enters the period and interest and can choose the factor. The routine will determine the table value.
190 SET CURSOR 15,18
195 PRINT "* 8 - Exit  *"
200 SET CURSOR 16,18
210 PRINT "*******************************************"
220 SET CURSOR 18,25
225 INPUT C
230 IF C = 8 THEN
240 GOTO 650
250 ELSEIF (C=1 OR C=2 OR C=3 OR C=4 OR C=5 OR C=6 OR C=7) THEN 252
260 GOTO 265
254 ELSE
256 SET CURSOR 20,10
258 PRINT "Input the Correct Choice?"
259 GOTO 225
260 END IF
265 CLEAR
270 SET CURSOR 6,10
280 PRINT "Enter the Number of periods (years)"
290 SET CURSOR 8,15
300 INPUT N
301 IF N < 0 THEN
304 SET CURSOR 20,6
306 PRINT "Enter a positive number of periods?"
307 GOTO 300
309 END IF
312
314 SET CURSOR 10,10
320 PRINT "Enter the Interest Rate (Example: 10)"
330 SET CURSOR 12,15
340 INPUT INT
342 IF INT < 0 THEN
344 SET CURSOR 20,6
346 PRINT "Enter a positive interest rate"
347 GOTO 342
349 END IF
350 LET I = INT * .01
360 LET A = (1 + I)^N
361 CLEAR
363 SET CURSOR 8,16
364 PRINT USING "Number of Periods =###":N
365 SET CURSOR 9,16
366 PRINT USING "The Interest Rate =##.#%":INT;
367 PRINT "%"
370
380 IF C = 1 THEN
390 LET F = A
395 SET CURSOR 14,16
400 PRINT USING "F/P =#####.####":F
410 ELSEIF C = 2 THEN
420 LET F = 1/A
425 SET CURSOR 14,16
430 PRINT USING "P/F =#####.####":F
440 ELSEIF C = 3 THEN
450 LET F = (A-1)/I
455 SET CURSOR 14,16
460 PRINT USING "F/A =#####.####":F
470 ELSEIF C = 4 THEN
480 LET F = 1/(A-1)
485 SET CURSOR 14,16
490 PRINT USING "A/F =#####.####":F
500 ELSEIF C = 5 THEN
510 LET F = (A-1)/(1*A)
515 SET CURSOR 14,16
520 PRINT USING "P/A =#####.####":F
530 ELSEIF C = 6 THEN
540 LET F = (1*A)/(A-1)
545 SET CURSOR 14,16
550 PRINT USING "A/P =#####.####":F
560 ELSEIF C = 7 THEN
570 LET F = (1/1) - (N/(A - 1))
574 SET CURSOR 14,16
580 PRINT USING "A/G = ************"; F
610 ELSE
615 END IF
618
620 DO
625 IF KEY INPUT THEN
628 GET KEY S
630 END IF
635 LOOP WHILE S <> 13
636 LET S = 000
640 GOTO 45
650 END SUB

1 *****************************************
2 | This subroutine contains a menu of all the depreciation  |
3 | method, the user can selected his/her choice through the |
4 | keyboard                                        |
5 *****************************************
10 | Subroutine DEPMEN                           |
11 *****************************************
12 EXTERNAL
13
14 SUB DEPMEN(K)
15
16 CLEAR
18 SET CURSOR 5,10
20 PRINT "*****************************************
21 SET CURSOR 6,10
22 PRINT "*
23 SET CURSOR 7,10
**Subroutine CASHFLOW**

```
100 REMOTE DEPRECIATIONS.
105 IF Period*Year >= 5 THEN
110 PRINT "Enter the correct number."
115 IF K < 1 OR K > 5 THEN
120 GOTO 110
125 INPUT K
130 SET CURSOR 20,10
135 PRINT "SET CURSOR 15,10"
140 SET CURSOR 14,10
145 PRINT "SET CURSOR 13,10"
150 PRINT "SET CURSOR 12,10"
155 PRINT "SET CURSOR 11,10"
160 PRINT "SET CURSOR 10,10"
165 PRINT "SET CURSOR 9,10"
170 PRINT "SET CURSOR 8,10"
175 PRINT "CHOOSE A DEPRECIATION METHOD"
```
20 EXTERNAL
22 SUB CASHFLOW(CF(),N)
25
35 LIBRARY "DEPMEN"
38 LIBRARY "SLDEP"
40 LIBRARY "SYDDEP"
41 LIBRARY "DDEP"
43 LIBRARY "USEDDEP"
45 LIBRARY "MACRS"
46 DIM G(100),D(100),X(100),C(100),INT(100),DEPR(100)
48
50 CLEAR
51 SET CURSOR 10,20
52 PRINT "Welcome to a Cashflow Determination...."
54 SET CURSOR 24,10
55
56 PRINT "Hit Any Key to Continue"
59 DO
65 IF KEY INPUT THEN
70 GET KEY S
75 END IF
80 LOOP WHILE S < 1
85
90 CLEAR
100 SET CURSOR 6,15
110 PRINT "Enter the Number of Periods (years?)"
115 SET CURSOR 8,15
116 INPUT N
118 IF N < 0 OR N > 99 THEN
120 SET CURSOR 19,6
122 PRINT "Enter a positive/or less then 100"
123 GOTO 116
124 END IF
125 SET CURSOR 10,15
130 PRINT "Enter the Effective Income Tax Rate"
(percent example: 40)"
140 SET CURSOR 12,15
145 INPUT T
147 IF T < 1 OR T > 100 THEN
150 SET CURSOR 21,6
152 PRINT "Enter a whole number (tax rate >= 1 and < 100)?"
155 GOTO 145
157 END IF
158
159 SET CURSOR 14,15

160 PRINT "Enter the initial investment"
161 SET CURSOR 16,15
162 INPUT INV
163 IF INV < 0 THEN
164 SET CURSOR 23,6
165 PRINT "Enter a positive investment?"
166 GOTO 162
167 END IF
168
170 CLEAR
175 FOR I = 2 TO N + 1
190
200 CLEAR
210 SET CURSOR 10,35
220 PRINT "WAIT"
230 PAUSE 5
240 CLEAR
250 SET CURSOR 5,10
260 PRINT "Enter the Gross Income (inflow?) for Period", I-1
265 SET CURSOR 6,15
270 INPUT G(I)
271 IF G(I) < 0 THEN
273 SET CURSOR 19,6
275 PRINT "Enter a positive inflow?"
277 GOTO 270
279 END IF
280
290 SET CURSOR 8,10
300 PRINT "Enter the Gross Expenses (outflows?) Period", I-1
305 SET CURSOR 9,15
310 INPUT C(I)
312 IF C(I) < 0 THEN
313 SET CURSOR 21,6
314 PRINT "Enter a positive number for outflow?"
315 GOTO 310
318 END IF
319
322 SET CURSOR 11,10
330 PRINT "Enter the Total Interest on Borrowed Money for Period", I-1
335 SET CURSOR 12,15
340 INPUT INT(I)
342 IF INT(I) < 0 THEN
344 SET CURSOR 23,6
345 PRINT "Enter a positive interest rate"
347 GOTO 340
348 END IF
349
350 NEXT I
360 CALL DEPMEN(K)
370 IF K = 1 THEN
380 CALL SLDEP(DEPR,N,INV,SALV)
400 ELSEIF K = 2 THEN
410 CALL SYDDEP(DEPR,N,INV,SALV)
420 ELSEIF K = 3 THEN
422 CALL DDDEP(DEPR,N,INV,SALV)
425 ELSEIF K = 4 THEN
430 CALL USEDEP(DEPR,N,INV,SALV)
431 ELSEIF K = 5 THEN
432 CALL MACRS(DEPR,N,INV,IFLAG)
433 END IF
434
435 IF IFLAG = 2 THEN
436   LET N = N + 1
437 END IF
440
444 LET CF(1) = -INV
445 FOR I = 2 TO N + 1
447   LET CF(I) = (G(I) - C(I) - INT(I)) * (1 - (T/100))
448   LET CF(I) = CF(I) + DEPR(I) * T/100
449 NEXT I
450
455 SET CURSOR 4,4
458 PRINT USING "Tax Rate = #":T,

460 PRINT "%"
462 SET CURSOR 6,4
464 PRINT "End of Inflows(+) Outflows(-) Interest on Depreciation"
465 SET CURSOR 7,4
468 PRINT " Year Borr. Money(-)"
470 SET CURSOR 8,4
472 PRINT "------ ----------- ----------- -----------

--------
475
478 LET C(1) = INV
479 IF N <= 17 THEN
480 FOR I = 1 TO N+1
482 SET CURSOR 8+1,4
485 PRINT USING "## $########## $########## $########## $##########.
".I-1,G(I),C(I),INT(I),DEPR(I)
490 NEXT I
505 ELSE
506
508 FOR I=1 TO 17
509 SET CURSOR 8+1,4
510 PRINT USING "## $########## $########## $###
"
NEXT I
514
515 DO
516 IF KEY INPUT THEN
518 GET KEY Z
520 END IF
522 LOOP WHILE Z <> 13
523 CLEAR
524 LET Z = 0
525 FOR I = 18 TO N + 1
526 SET CURSOR 1-17,4
528 PRINT USING "" $********** $********** $******
529 $********** $********** $********** $**********
530 NEXT I
531 END IF
532 DO
534 IF KEY INPUT THEN
536 GET KEY ZZ
538 END IF
540 LOOP WHILE ZZ <> 13
542 LET ZZ = 0
544 CLEAR
545 END SUB

This subroutine uses the current laws depreciation methods!
by subroutine cashflow, basically two method of depreciation are allowed under the current law
19
20 EXTERNAL
25 SUB MACRS(DEPR(),N,INV,FLAG)
30 DIM BV(100),DDDEP(100),SLDEP(100)
40 CLEAR
44 SET COLOR "WHITE"
45 SET BACK "RED"
50 SET CURSOR 10,15
55 PRINT "This will determine the depreciation based on the"
60 SET CURSOR 12,15
65 PRINT "on the Tax Reform Act of 1986....."
70 SET CURSOR 23,10
75 PRINT "Hit Any Key to Continue"
80 DO
85 IF KEY INPUT THEN
90 GET KEY Z
100 END IF
105 LOOP WHILE Z < 1
109
110 CLEAR
120 SET CURSOR 5,10
130 PRINT "********************************************************************************
135 SET CURSOR 6,10
140 PRINT "*
145 SET CURSOR 7,10
150 PRINT "* CHOOSE A DEPRECIATION METHOD
155 SET CURSOR 8,10
160 PRINT "*
170 SET CURSOR 9,10
180 PRINT "* 1 - Straight Line (no salvage value
185 SET CURSOR 10,10
190 PRINT "* 2 - Declining Balance Switching to SLD
195 SET CURSOR 11,10
198 PRINT "*
199 SET CURSOR 12,10
200 PRINT "********************************************************************************"
210
215 SET CURSOR 15,15
220 INPUT K
225 IF K = 1 THEN
230 CLEAR
235 SET CURSOR 10,10
240 PRINT "You Have Chosing the Straight Line Depreciation Method"
250 SET CURSOR 11,10
260 PRINT "Do You Want to Continue (y/n)?"
265 SET CURSOR 15,15
268 INPUT ANS$
270 IF ANS$ = "Y" OR ANS$ = "y" THEN
280 GOTO 550
290 ELSEIF ANS$ = "N" OR ANS$ = "n" THEN
300 GOTO 110
310 ELSE
320 SET CURSOR 20,10
330 PRINT "Input (y/n)?"
335 GOTO 268
340 END IF

350 ELSEIF K = 2 THEN
360 CLEAR
365 SET CURSOR 10,10
370 PRINT "You Have Chosing the Declining Switching to SLD Method"
380 SET CURSOR 11,10
390 PRINT "Do You Want to Continue (y/n)?"
393 SET CURSOR 15,15
395 INPUT ANS2$
400 IF ANS2$ = "Y" OR ANS2$ = "y" THEN
410 GOTO 780
420 ELSEIF ANS2$ = "N" OR ANS2$ = "n" THEN
430 GOTO 110
440 ELSE
450 SET CURSOR 20,10
460 PRINT "Input (y/n)?"
470 GOTO 395
480 END IF
490 ELSE
500 SET CURSOR 20,10
510 PRINT "Input the Correct Selection"
515 GOTO 220
520 END IF
530
540 'Straight Line Depreciation
545
550 CLEAR
640 LET DEPR(1) = INV/(2 * N)
650 LET DEPR(N+1) = DEPR(1)
655
660 FOR I = 2 TO N
670 LET DEPR(I) = INV/N
680 NEXT I
685 SET CURSOR 2,4
688 PRINT "Using (MACRS) Straight Line Depreciation"
690 SET CURSOR 3,4
692 PRINT USING "Number of Periods = ###":N
695 GOTO 1270
700
760 'Declining Method Switching to Straight Line Depreciation
770
780 CLEAR
870
880 IF N > 0 AND N < 15 THEN
890 LET ALPHA = 2
900 ELSEIF N >= 15 AND N < 25 THEN
910 LET ALPHA = 1.5
920 ELSE
930 SET CURSOR 15,10
940 PRINT "N Must be between 0 to 25 years, enter new values"
950 SET CURSOR 17,15
951 INPUT NN
954    LET N = NN
955    END IF
958    CLEAR
1000
1010    CLEAR
1020
1030    LET DDDEP(1) = (ALPHA*INV)/(2*N)
1040    LET SLDEP(1) = INV /(2*N)
1050    LET BV(1) = INV
1070    LET TDD = DDDEP(1)
1080    LET TSLD = SLDEP(1)
1090
1100 FOR I = 2 TO N
1110    LET DDDEP(I) = (ALPHA/N) * (BV(I-1) - DDDEP(I-1))
1115    LET SLDEP(I) = (BV(I-1) - DDDEP(I-1))/(N-I+1.5)
1120    IF DDDEP(I) < SLDEP(I) THEN
1130        LET DDDEP(I) = SLDEP(I)
1145    END IF
1150    LET BV(I) = INV - TDD
1160    LET TDD = TDD + DDDEP(I)
1180 NEXT I
1185
1190    LET DDDEP(N+1) = SLDEP(N)/2
1195 FOR I = 2 TO N+2
1200    LET DEPR(I) = DDDEP(I-1)
1245 NEXT I
1251    LET IFLAG = 2
1255    SET CURSOR 2,4
1256    PRINT "Using (MACRS) Declining Switching to Straight Line Depreciation"
1258    SET CURSOR 3,4
1260    PRINT USING "Number of Periods = ###":N
1262    SET CURSOR 10+N,55
1265
1270 END SUB
This subroutine determines the depreciation of an investment through the straight line depreciation method. It has a of 100 periods.

Subroutine SLDEP

EXTERNAL
SUB SLDEP(DEPR(),N,INV,SALV)
CLEAR
SET CURSOR 11,20
SET CURSOR 10,18
PRINT "Enter the Estimated Salvage Value"
SET CURSOR 12,20
INPUT SALV
IF SALV < 0 THEN
SET CURSOR 21,6
PRINT "Enter a positive salvage value?"
GOTO 130
END IF
CLEAR
FOR I = 2 TO N + 1
LET DEPR(I) = (INV - SALV)/N
NEXT I
SET CURSOR 2,4
PRINT "Using Straight Line Depreciation";
PRINT USING "Salvage Value = $$$$# ###.SALV"
180 SET CURSOR 3,4
185 PRINT USING "Number of periods = ###":N
190
195 END SUB

5 |******************************************************************|
7 ! This subroutine determines the depreciation of a proposal !
8 ! through sum of the years digit depreciation method. It has !
9 ! a capability of up to 100 periods.
13 |******************************************************************|
15
17 |******************************************************************|
19 ! Subroutine SYDDEP
21 |******************************************************************|
23
25 EXTERNAL
30 SUB SYDDEP(DEPR(),N,INV,SALV)
35
90 CLEAR
95 SET CURSOR 10,18
100 PRINT "Enter the Estimated Salvage Value"
115 SET CURSOR 12,20
120 INPUT SALV
121
122 IF SALV < 0 THEN
124 SET CURSOR 21,6
126 PRINT "Enter the salvage value as a positive number?"
128 GOTO 122
130 END IF
135
138 CLEAR
140 FOR I = 2 TO N + 1
150 LET DEPR(I) = ((2*(N - I + 2))/(N*(N + 1)))*(INV-SALV)
160 NEXT I
170 SET CURSOR 2,4
175 PRINT "Using Sum of Years Digit Depreciation";
178 PRINT USING "Salvage Value = $$$$####": SALV
180 SET CURSOR 3,4
185 PRINT USING "Number of Periods = ###": N
190 END SUB

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>

30 EXTERNAL
35 SUB DDDEP(DEPR(),N,INV,SALV)
40
42 CLEAR
45 SET CURSOR 10,18
50 PRINT "Enter the Estimated Salvage Value"
55 SET CURSOR 12,20
60 INPUT SALV
62 IF SLAV < 0 THEN
65 SET CURSOR 6,22
70 PRINT "Enter positive salvage value?"
75 GOTO 60

80 END IF
95
100 CLEAR
110 LET R = 2/N
115 LET TDEP = 0
120 FOR I = 2 TO N
130 LET DEPR(I) = R * ((1 - R) ^ (1-2)) * INV
135 LET TDEP = TDEP + DEPR(I)
140 NEXT I
142 LET DEPR(N+1) = INV - SALV - TDEP
150
155 SET CURSOR 2,4
160 PRINT "Using Double Declining Depreciation"
165 SET CURSOR 3,4
170 PRINT USING "Number of Periods = ###":N
175 END SUB

5 "----------------------------------------------------------------------"      
7 | This subroutine determines the depreciation of aninvestment through depreciation based on usage. It has a capability of 100 periods.      
8 |----------------------------------------------------------------------"      
10 "----------------------------------------------------------------------"
11 | Subroutine USEDEP
12 |
15 |
17 "----------------------------------------------------------------------"
19 |
21 "----------------------------------------------------------------------"
22 |
30 EXTERNAL
35 SUB USEDEP(DEPR(),N,INV,SALV)
38 DIM PUSE(100)
40
45 CLEAR
50 SET CURSOR 8,15
55 |
100 SET CURSOR 10,18
110 PRINT "Enter the Estimated Salvage Value"

120 SET CURSOR 12,20
130 INPUT SALV
132 IF SALV < 0 THEN
134 SET CURSOR 21,6
135 PRINT "Enter a positive salvage value?"
136 GOTO 130
138 END IF
139
140 SET CURSOR 13,18
145 PRINT "Enter the Estimated Lifetime Usage"
150 SET CURSOR 15,20
155 INPUT LUSE
156 IF LUSE < 0 THEN
157 SET CURSOR 23,6
158 PRINT "Enter a positive lifetime use?"
159 GOTO 155
160 END IF
162 CLEAR
165
168 FOR I = 2 TO N+1
170 SET CURSOR 10,18
175 PRINT "Enter the Estimated Usage in Period ",I-1
177 SET CURSOR 12,20
180 INPUT PUSE(I)
182 IF PUSE(I) < 0 THEN
184 SET CURSOR 20,6
185 PRINT "Enter a positive period use?"
186 GOTO 180
188 END IF
190 CLEAR
195 NEXT I
197 CLEAR
200 FOR I = 2 TO N + 1
210 LET DEPR(I) = ((INV - SALV) * PUSE(I))/LUSE
220 NEXT I
222 SET CURSOR 1,4
225 PRINT "Based on Usage Depreciation",
228 PRINT USING " Lifetame Usage =##########":LUSE
230 SET CURSOR 2,4
232 PRINT USING "Number of Periods = ###":N;
233 PRINT USING "Salvage Value = $$$$###": SALV
234 SET CURSOR 6,70
236 PRINT "Period"
237 SET CURSOR 7,70
238 PRINT "Usage"
239 SET CURSOR 8,70
240 PRINT "-----"
244 FOR I = 1 TO N+1
245 SET CURSOR 8+I,71
250 PRINT PUSE(I)
255 NEXT I
260
270 END SUB
### VARIABLE LISTING

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPR()</td>
<td>Depreciation charges, an array of the periods.</td>
</tr>
<tr>
<td>DDDEP()</td>
<td>Declining depreciation (MACRS), an array.</td>
</tr>
<tr>
<td>SLDEP()</td>
<td>Straight line depreciation (MACRS), an array.</td>
</tr>
<tr>
<td>TDD</td>
<td>Total depreciation charges.</td>
</tr>
<tr>
<td>BV()</td>
<td>The book value, an array.</td>
</tr>
<tr>
<td>PUSE()</td>
<td>Each period usage of the asset.</td>
</tr>
<tr>
<td>LUSE</td>
<td>Life usage of the asset.</td>
</tr>
<tr>
<td>T</td>
<td>The tax rate.</td>
</tr>
<tr>
<td>r</td>
<td>Declining depreciation rate.</td>
</tr>
<tr>
<td>Alpha</td>
<td>IRS declining depreciation rate (200% or 150%)</td>
</tr>
<tr>
<td>N</td>
<td>The useful life of the project, usually in years.</td>
</tr>
<tr>
<td>SALV</td>
<td>The salvage value of an investment.</td>
</tr>
<tr>
<td>INV</td>
<td>The initial investment.</td>
</tr>
<tr>
<td>CF()</td>
<td>The cash flows, an array.</td>
</tr>
<tr>
<td>TCF</td>
<td>The total amount of cash flows.</td>
</tr>
<tr>
<td>HR</td>
<td>The hurdle rate (interest rate).</td>
</tr>
<tr>
<td>INT</td>
<td>The amount paid in interest.</td>
</tr>
<tr>
<td>ATT$()</td>
<td>The identity of an attribute, a string.</td>
</tr>
<tr>
<td>NOSA</td>
<td>The number of criteria or attribute under consideration.</td>
</tr>
<tr>
<td>WEIGHT()</td>
<td>The importance rating of an attribute.</td>
</tr>
<tr>
<td>TOTAWT</td>
<td>The total weight, sums of all the attribute weights.</td>
</tr>
</tbody>
</table>
NALT  The number of alternatives or proposals under consideration.

X(I,J)  The rating of alternative I on meeting attribute J.

N()  The overall score of each alternative.

NPV  The net present value.

PW  Present worth.

F  Future worth factor.

P  Present worth factor.

A  Sinking fund factor, or capital recovery factor.

G  Uniform gradient series factor.

CR  Capital recovery.

PBP  Payback period.

PB()  Project balance, an array.

PBT  Total amount of the project balance.

UP  The upper limit in the bisection method.

DOWN  The lower limit in the bisection method.

ERROR  The error value in the bisection method (.00001).

IFLAG  Return to cashflow when the MACRS is used.

CHOICE  Selecting an option from the menu.

SELEC  Selecting an option from the menu.

ANS$  Giving an answer (y/n)/

Y/y  Yes.

N/n  No.

Z,ZZ,S,SS  Pressing any key or the return key.

I,J,K  Loop counters.
Appendix C
JANT User Manual
C-1  Getting Started

JANT is designed as a user-friendly package, allowing the user to have control in the evaluation process. It has more than adequate capacity and memory, and it provides feedback when the capacity is exceeded. It is very easy to use requiring a short learning period. It is menu driven and often provides the user with guidance and direction. For complete description refer to chapter 5.

- JANT will accept upper or lower letters, for example, Y/y for yes.
- JANT is formatted as a system diskette, thus there is no need for a DOS diskette.
- Will reject characters if entered as numbers.
- Will reject improper data, such as a negative number of periods or interest rate.
- It is menu driven, very easy to use; follow the instructions on the screen.

<>insert diskette (JANT) in drive A: or B: and type
<> JANT <ret> Wait 20 to 40 seconds depending on the speed of your computer. The following will be displayed:
1.1 Option 1 - Strategic Evaluation
The following is displayed:
You have chosen strategic evaluation
Do You Want to Continue (y/n)?

- y will continue
- n will return to previous menu
<> y <ret> The following is displayed:
Welcome to a Strategic Evaluation Session.....
-
-
Hit Any Key to Continue?
<> any key <ret> The following is displayed:
How Many Attributes Are Under Consideration
<> (enter number of attribute) <ret> The following is displayed:
Input the Identity of Attribute 1
Input the identity of Attribute n

<> (identify attribute n) <ret> The following is displayed:

Input the Rating for the Attribute ....... Identity of Attribute 1

Choose From the Following Menu:

1 - Very Important
2 - Important
3 - Necessary
4 - Can be Helpful
5 - Unimportant

After all the attributes are rated, the following is displayed:

How Many Alternatives/Proposals Are Under Consideration

<> (enter number of proposals) <ret> The screen is cleared and the following message is displayed:

Input the Identity of Alternative/Proposal 1

<> (identify alternative 1) <ret>

.<. .

Input the Identity of Alternative n

<> (identify alternative n) <ret>

After all the alternatives are identified JANT will display:
Rate Each Alternative/Proposal With Respect to Each of the Attributes From the List Below?

Hit Any Key to Continue?

<> (enter any key) <ret> will display:

Enter Rating of Proposal...(Identity of Alternative)*** on Attribute ...(Identity of attribute)

Choose From The Following Menu

1 - Superior
2 - Excellent
3 - Good
4 - Above Average
5 - Average
6 - Below Average
7 - Poor

<> enter rating of alternative 1 *** on attribute 1 <ret>

After all the alternatives are rated based on the attributes/criteria, then the final scores are displayed:

<table>
<thead>
<tr>
<th>ALTERNATIVE</th>
<th>TOTAL SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>identity of alternative 1</td>
<td>its score</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>identity of alternative n</td>
<td>its score</td>
</tr>
</tbody>
</table>

The above table will be display on the screen until the user enters the return key, if the output data does not fit on one screen
then the remaining data is displayed on the next screen. The user can get a print out by:
<> (hold shift key down and enter print screen key)
After entering the return key JANT returns to the main menu.

This evaluation process involves non-monetary attributes or both non-monetary and monetary attributes depending on the problem and the firm's goals and strategies. The following are some suggested non-monetary attributes/criteria that can be used to evaluate automation and new technologies programs. They are as follows:

- Flexibility in changeover
- Ease of operation
- Time savings per part produced
- Reinforcing the firm's competitive strategy
- Meeting the firm's goals
- Improving the firm's standing
- Effects on lead time
- Inventory control
- Effects on Quality
- Productivity
- Capacity
- Controls
- Long Life
- Riskiness, lack of
- Serviceability/maintainability
- Management/Engineering efforts
• Future options
• Customer service
• Contribute toward CIM's.

C-1.2 Option 2 - Financial

This selection will allow the user to select a financial method and evaluate a given proposal/project based on the chosen method.

<>2  <ret> The following message will appear on the screen:
You Have Chosen Financial Evaluation
Do You Want to Continue (y/n)?
- n will return to main menu
- y will continue financial evaluation
The following menu (financial menu) will be displayed:

1 - Discounted Cash Flows
2 - Payback Period
3 - Project Balance/Capital Recovery
4 - Exit

Option 4 will exit financial evaluation and return to the main menu

Option 1
<>1  <ret> The following is displayed:
You Have Chosen Discounted Cash flows
Do You Want to Continue (y/n)?
n - return to financial method menu
y - will continue discounted cash flows evaluation

Option 2

2 - Internal Rate of Return (IRR)

Option 3

3 - Project Balance/Capital Recovery

After the selection of any financial method JANT will display:
Welcome to a (identity of method) evaluation ......
-
-
Hit any key to continue
<> any key <ret>

The user is asked to enter the number of periods (years), the interest rate (depending on the method), and the yearly cash flows (if available). The interest rate is entered as a whole number (not a percentage), for example 15% should be entered as 15 and not .15. The number of periods (years) can be up 100 periods even though in reality the number of periods rarely exceeds 10 years. JANT will reject more than 100 periods or a negative number of periods thus ensuring the inputting of proper data.

C-1.2.1 Net Cash Flows

It was mentioned above that the yearly cash flows can be entered through the keyboard or JANT will assist the user in determining them. When the net cash flows are entered through the keyboard they must be entered as negative (outflows) and positive (inflows) numbers. The initial investment is considered as outflow at the end of year zero, thus it must be entered as a negative number. For example, the number in table B-1 are entered as they are written or appear in the table. When JANT is asked to assist the user in determining the yearly cash flows, then the inflows and outflows are entered as positive numbers. Should the user enter an outflow as negative number, JANT will prompt the evaluator to input a positive outflow. The amount of interest on borrowed capital to finance the
project is entered as a positive number. The tax rate must be entered as a whole number and not a fraction, the user is provided with an example on the screen.

Table B-1. The cash flows of a certain project.

<table>
<thead>
<tr>
<th>End of Period</th>
<th>Net Cash Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-$10,000</td>
</tr>
<tr>
<td>1</td>
<td>$-1,000</td>
</tr>
<tr>
<td>2</td>
<td>$10,000</td>
</tr>
<tr>
<td>3</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

When the cash flows are not available and the user seeks the assistance of JANT, then the following is displayed:

Welcome to cash flows evaluation......
-
-
Hit any key to continue
<> any key <ret> will displays:
Enter the tax rate (Example 40)?
<> tax rate <ret> The following is displayed:
Enter the Initial Investment
<> investment <ret> will clear the screen and displays:
Enter the Net Cash Flows (inflows) at the End of Period 0
<> (net inflows) <ret> will display:
Enter the Net Cash Flows (Outflows) at the End of Period 0
<> (net outflows) <ret> will display:
Enter the Interest on Borrowed Capital at the End of Period 0
<> (amount paid in interest) <ret> will clear the screen.
Enter the Net Cash Flows (inflows) at the End of Period n
<>
<ret>
<>
<ret>
<>
<ret>
<>
<ret>

Enter the Net Cash Flows (Outflows) at the End of Period n
<>
<ret>
<>
<ret>
<>
<ret>
<>
<ret>
<>
<ret>

Enter the Interest on Borrowed Capital at the End of Period n
<>
<ret>
<>
<ret>
<>
<ret>
<>
<ret>
<>
<ret>

Will clear the screen and display the following menu:

**CHOOSE A DEPRECIATION METHOD**

1 - Straight Line
2 - Sum of the Years-Digit
3 - Double Declining
4 - Based on Usage
5 - MACRS (current IRS method)

After choosing a depreciation method the following message is displayed:

You have chosen (identity of the method)
Do you want to continue (y/n)
- n will return to depreciation menu
- y will continue
<>
y
<ret>

All the depreciation methods prompt the user to input the initial investment (positive), and the salvage value (except MARS methods).
Based on usage depreciation method require the user to input the estimated life usage of the project and this can be the number of parts, number of tons, number of gallons, etc. and each period usage. Under MACRS the user can choose either straight line depreciation or declining depreciation. In declining depreciation a switch is made to straight line when the depreciated amount through declining becomes less than the depreciated amount through straight line. After choosing option 5 and entering yes (y) to continue the following menu is displayed:

**CHOOSE A DEPRECIATION METHOD**
1- Straight Line (no salvage value)
2- Declining Balance Switching to SLD

After chosen an option, the depreciation charges are determined and a table is displayed on the screen.

C-1.3 Option 4 - Table

This option allows the user to determine the interest factor for any interest rate and a number of periods/years. After its selection the following menu is displayed:

1 - F/P (find F given P)
2 - P/F (find P given F)
3 - F/A (find F given A)
4 - A/F (find A given F)
5 - P/A (find P given A)
6 - A/P (find A given P)
7 - A/G (find A given G)
8 - P/G (find P given G)
9 - F/G (find F given G)
10 - Exit

**Option 10** will exit and return to the main menu.
Other options: the user is asked to enter the interest rate and the number of periods. JANT outputs the number of periods, the interest rate, and the appropriate interest factor. The output remains on the screen until the return key is pressed. After the return key is entered JANT returns to the above menu.