Asset Abandonment
Analysis and Decision Making
Evaluation of Asset Abandonment Decision Models

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1978

Submitted to the Graduate Faculty of the
Department of Finance
College of Business
Oklahoma State University
in partial fulfillment of
the requirements for the Degree of
MASTER OF BUSINESS ADMINISTRATION
December, 1986

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Title of Study: Asset Abandonment
Analysis and Decision Making
Evaluation of Asset Abandonment Decision Models

Pages in Study:

Candidate for Degree of Master of Business Administration

Major Field: Business Administration

Scope and Method of Study:

Abandonment is something that happens everyday within companies and with consumers. Nearly every person has decided to throw something away at one point in their life. Businesses make similar decisions every day. Sometimes the decisions are made voluntarily by the companies. Market and economic conditions frequently change. These changes require that projects and assets be reviewed periodically with respect to current and future profitability. Those assets (or projects) whose future profitability is questioned become candidates for possible abandonment. Many times certain projects only remain profitable when interest rates are low, or energy costs high, or tax laws favor investment. When their direction changes, the wise manager must make the decision that continues to enhance the profits of the firm.

This paper will review the types of models presented for use in making abandonment decisions and how these apply to the abandonment of physical assets. Two new models will be developed to assist the manager in making these abandonment decisions. Analysis will include reviewing the important variables and assessing the relative weight of each.

Findings and Conclusions:

The models developed provide an enhancement to those found in the literature. The two new models proposed are contrasted with a

model presented by another author. In the particular example, circumstances occur where the published model does not indicate abandonment and the new models do. It is these borderline cases where the use of the proper model can make a big difference in a go/no go decision.

It is the very fact that these things do change that causes us to not only evaluate the future cash flows and abandonment value but also make the decision whether or not to abandon the asset or keep it. It is hoped that this paper provides the analyst with a tool to evaluate the question and make the proper decision.

ADVISORS APPROVAL ______________________________

Asset Abandonment

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Chapter I

Introduction

Abandonment is something that happens everyday within companies and with consumers. Nearly every person has decided to throw something away at one point in their life. In some cases there is no forethought involved as with a candy wrapper. At other times, it is not apparent to the individual that he should consider such a decision. That is, until the car dies on an open road ten miles from the next telephone and/or help. The person finds out that it is going to cost six hundred dollars to repair and he decides that he'd rather spend twelve hundred dollars on a "new" used car than fix the other one, because he suspects other things will break soon as well. So he abandons his (or more accurately sells it for scrap or gives it away for scrap) car and gets the "new" one.

Businesses make similar decisions every day. Sometimes the decisions are made voluntarily by the companies. Market and economic conditions frequently change. These changes require that projects and assets be reviewed periodically with respect to current and future profitability. Those assets (or projects) whose future profitability is questioned become candidates for possible abandonment. Many times certain projects only remain profitable when interest rates are low, or energy costs high, or tax laws favor investment. When their direction changes, the wise manager must make the decision that continues to enhance the profits of the firm.

The inability to meet the technical aspects of a project may cause abandonment of a project. Last year, after tens of millions of dollars in research, the company threw in the towel. "As we got more into it, the more we found that the technical challenge was perhaps unachievable," say Will D Carpenter, vice president of agricultural technology for Monsanto Company[1]. This abandoned project dealt with a plant growth regulant Monsanto was trying to develop.

Technology can also cause the obsolescence of physical assets which require abandonment and/or replacement. This happens especially often in areas where technology is moving along at an alarming rate. Recently, computers have been on this ride. Many times, by the time a company gets a system installed the system has been replaced by a new model. For other companies, such as automobile manufacturers, manufacturing technology makes current facilities outdated. The current facility cannot be used to house a modern factory and the plant must be abandoned and a new site must be selected.

There are instances when abandonment is involuntary. Bankruptcy is a big reason. Firms must abandon assets to lower costs or sell them to raise cash. The survival of the business depends on this. Loan agreements can also require abandonment or disposal of assets.

Projects, plants, products, and other assets, are eliminated from use by companies every day for a variety of reasons. Capital budgeting has almost exclusively dealt with the approval of a project (or

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[1]"Shakeout in Agrichemicals Is Under Way," The Wall Street Journal, August 11, 1986, page 6.

disapproval) but, has not dealt much in the area of what to do with an existing asset such as a plant that no longer fits the corporate plan or is unprofitable. The long run goal might be to preserve what is left of the company. This is much like the football team that is 21 points behind with two minutes left in the game. The primary intent is to protect the health and well being of the team and especially the quarterback. There will most certainly be another game and they want to be a viable force. They abandon the prospect of winning the game.

There are many reasons why abandonment does not happen. Quite often a manager or management team has sentimental value associated with the asset. Perhaps this was the founders first plant or first headquarters, or, this project was initiated by this manager. The manager feels as though he would be admitting fault by pulling the plug.

Procrastination is another culprit. Management realizes that they need to review the projects/assets but there is always something that needs their attention first. This type of attitude can cause assets/projects to continue to exist with the result being an unprofitable drain on the company. The company no longer uses capital appropriately.

Bad management can also be a cause of neglect. Some managers just don't pay attention to their business the way that they should. The result, obviously is that unprofitable ventures continue and drive business into the ground.

As has been presented earlier here, there are many types of abandonment in business today. Abandonment can touch four main areas. Starting with abandonment of an industry. Steam locomotives are a good example of an industry that evolved and slowly companies began to get out of the manufacture of steam locomotives. Some went on to make modern locomotives and others vanished.

The second area is abandonment of a business. Companies decide that they do not hold a significant market share and decide to withdraw from the business completely. The other businesses absorb this share of the market and there is now one less competitor. Historically, this has happened many times over the years. Probably the best example is the automobile industry. In the early 1900's there were numerous auto manufacturers. Today in the United States, there are essentially four major American auto manufacturers. This is changing some what now with the emergence in the U.S. of foreign manufacturers setting up facilities.

Within a company individual projects may be abandoned. Projects are abandoned at many stages, all the way from conception to after product introduction. Reasons can again follow from financial (not enough profit), to technical (not able to develop in a reasonable amount of time and money), to economic (not enough funding), etc.

This paper will review the types of models presented in the literature for use in making abandonment decision of physical assets. A new model will be developed to assist the manager in making these type of decisions. Analysis will include reviewing the important variables and assessing the relative weight of each.

Chapter II

Abandonment in Capital Budgeting

Abandonment is considered by many to be a part of the capital budgeting procedure. It sometimes takes the form of being called salvage value. However, abandonment includes more than just what the asset is worth as salvage or scrap. The concept and even the thought of abandonment is not a very positive image. The word implies that something is not expected to last forever. No matter how true it might be, presenting your project to the board of directors with your estimates of the abandonment costs may not be politically popular. However, in some industries, especially the natural resources industries, abandonment is certain. For instance in the mining industry, ore eventually will run out. That goes the same for oil, coal, gold, diamonds, and others. It would be foolish to believe that any resource is unlimited. It follows that some day the coal mine, oil well or whatever, will run out of resources and abandonment will follow. Many times there will be significant costs associated with abandonment.

In other industries, abandonment is not as obvious or predictable. Many outside factors cause a company to have to consider abandonment of an asset such as a plant that only five years earlier was a most promising asset. New laws and regulations are created all the time which affect the cost and timing of abandonment. A variety of agencies of the government such as Occupation Safety and Health Administration

(OSHA), Environmental Protection Agency (EPA), Financial Accounting Standards Board (FASB) can make changes to current environmental, safety, or accounting methods. Recently unions and their demands and strikes can make an asset so uneconomical that it must be shut down. We have seen in recent years the closure of operating facilities due to union demands. The threat of closure has also been used by companies recently to try to reduce costs.

A definition of abandonment is simple, yet there are some qualifiers. Just because an asset is sold for scrap does not discount the fact that it was abandoned. Perhaps part of the definition should include "no longer can perform its intended function" as the main qualifier. Land is not typically abandoned while the structures located on it are. In some cases it goes even farther, the building remains intact but the interior is abandoned. There are old gold and silver mines that are still visible in the west that were abandoned because the ore ran out or it was uneconomical to continue mining. Therefore, a good definition might be as follows: Abandonment of an asset takes place when the asset can no longer perform its intended function either physically or economically.

As stated before, companies abandon assets all of the time. In some cases, there is little thought and in others, a considerable amount of effort is expended because the asset is a major asset and the consequences can be enormous. For instance, in the oil industry, low producing (sometimes called stripper) wells may become uneconomical due to a reduction in market price for the oil. This happened in early 1986. The decision to operate these wells is based almost entirely on the forecast for prices. There are certain costs associated with abandonment. These include (but may not be limited to) dismantling of the mechanical pumps, cementing and sealing the well, and local clean up of the area (and potentially disposal fees). Abandonment in this case is somewhat final. There is very little to return to. The same holds true for larger plants. once a plant such as a refinery or assembly plant is shut down, one cannot plan on simply reopening without large start up costs. The trained work-force leaves, mechanical equipment "freezes up", supply, distribution, and inventory channels decay, and other forces all create a large obstacle to the conception of "shutting the place down for a couple of years until the market turns around".

Abandonment of physical assets occurs at various phases of project/asset lifetime. These time periods are summarized into four categories. They are as follows:

I. Project creation/design

II. Project development/construction

III. During useful life

IV. After (or at the end of) useful life

Each of these phases have different abandonment consequences and costs. Figure 1 depicts the general direction that the abandonment costs will follow over the life of an asset. Realize of course, phases I and II may be very short such as in purchase of a car or truck for the business and very long for building an auto assembly plant or a nuclear power plant.

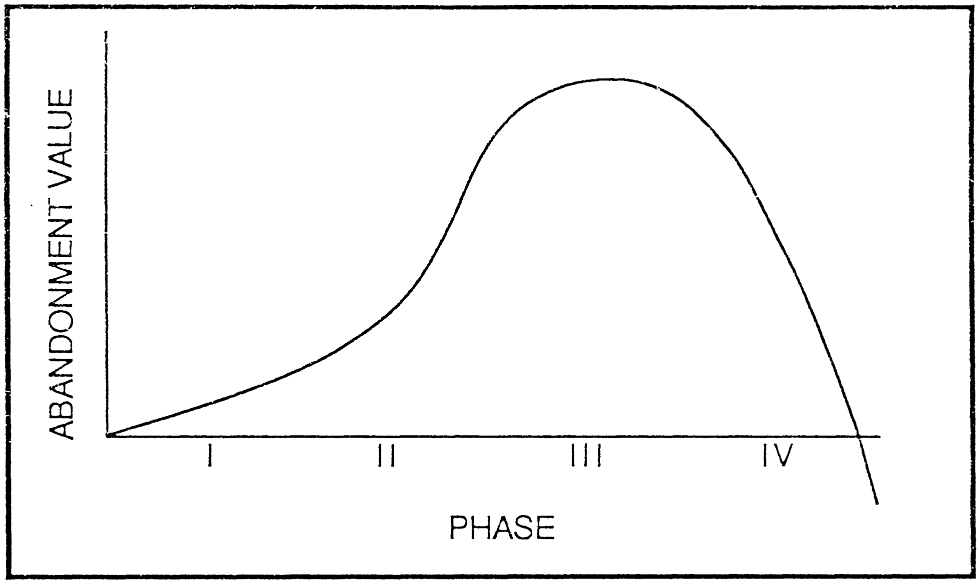

Figure 1
Change in Abandonment Value During
Each Phase of an Assets Life

Phase I - Project Creation/Design

Phase I shows abandonment increasing because objects and designs are being created which have value. Here ideas are put down on paper and developed into a true potential project. Preliminary financial data such as pro forma income statements, profit and loss statements, and rates of return are produced to be presented for project approval. Preliminary figures are also brought together to define project costs. An architect or engineering firm is consulted for approximate design cost and perhaps a preliminary design.

It is at this point that a firm may learn more about the planned product. Estimates of fixed costs can now be forecast with a greater precision. This estimate is then used to determine the total costs to produce the product. The firm can now compare the total cost to their estimate of what the product will sell for. It is also at this point where many projects have been cancelled (or shelved) because continuation is not economical. Here abandonment value is much larger than the present value of the cash flows (because they are zero here).

Typically the first phase consists almost entirely of labor and, therefore, the only abandonment costs are the labor and associated expenses. Probably, this is the most inexpensive phase of a whole project. There is no abandonment value unless you consider that the design might be worth something to someone else. Abandonment here involves a small loss when compared to losses in subsequent phases.

Abandonment, however, takes place at this phase in many instances. Companies may decide after they have looked at their potential product, market, and production costs more closely, that it is uneconomical to continue with the project. The company (or individual) has the option of trying to redesign to lower cost of production, however, this action may not alter project returns.

Phase II - Project Development/Construction

Phase II occurs when actual engineering design and plant construction occurs. In large plants, the asset is slowly assembled. In some cases a large capital expenditure of tens to hundreds of millions of dollars begins. At this point the abandonment value continues to increase because the plant is partially complete and has some tangible value.

Probably, in most instances, abandonment at this phase does not happen very often. Companies presumably have done their homework in Phase I and the abandonment question is not considered. That is not to say that it never happens. After spending millions of dollars, may oil companies have abandoned dry holes. Exxon recently abandoned its shale oil project in Colorado when oil prices started to go lower instead of continuing on an uphill climb.

Phase III - Useful Life/Product Introduction

During this phase, the plant is in production and the products are being distributed. The full capital investment has been made and depreciation starts. The value of the plant now stays the same (or increases slightly) for a while. This occurs in cases where market demand outstrips the ability of the plant to produce.

Depreciation, however, will eventually begin and abandonment value begins to decrease as the plant gets older. In some cases, this process is many years long. Refineries, chemical plants and offshore oil production platforms to name a few are expected to last 30 to 40 years. Other structures may last longer while some last for a shorter number of years.

Abandonment in this phase is probably the most complex and expensive. Under conventional capital budgeting, the plant remains in production as long as cash flows are positive. Very little if any effort is generally spent to analyze the asset, review the current rate of return and compare it to alternate opportunities.

In any event, companies do make the difficult decision to abandon in Phase III. The Coca Cola Company introduced and began to distribute its reformulated Coke when, due to public response, the product was replaced with the old formula and renamed "Coke Classic".

Generally, severe circumstances are necessary to cause abandonment during this phase. Many of these circumstances, such as economic conditions, market conditions, etc., were mentioned in Chapter

I. They can all affect the cash flows and many cause an asset to be abandoned before its time.

Phase IV - End of Useful Life

In Phase IV, the decision becomes more of a black and white decision. The asset now is at the point where replacement or abandonment is necessary. Years of use have taken their toll and the asset is no longer productive or efficient. In any event, the decision has somewhat been made but the timing has not been determined. Such factors like clean up costs in the chemical industry, land reclamation, etc all can affect the timing and cost of the asset abandonment.

The decision in a "like for like" abandonment / replacement may bring together not only the abandonment costs / values but also the fact that the new replacement is more efficient, more productive, takes less (possibly valuable) physical space, or other criteria. All of these (and more) can affect the timing of the decision.

As in Phase III, the abandonment value is equal to the value of the asset minus the cost of disposal. The cost of disposal may include such items as removal of the asset and clean up activities to make the site safe, meet EPA requirements, etc.

Review of Published Articles

The literature brings out the fact that insufficient attention has been given to abandonment in capital budgeting. Most of the classical methods used in capital budgeting analyze a problem as if the company was planning to continue the project for its entire life. The authors of these papers point out that for capital to be optimally allocated the possibility of abandonment must be considered in the capital budgeting process.

Abandonment in capital budgeting is a concept that has only been given attention in the last twenty years or so. Robichek and Van Horne were some of the first authors to address this subject in the literature[2]. They proposed that a project should be abandoned at that point in time when its abandonment value exceeds the net-present value of the projects subsequent expected future cash flows discounted at the cost-of-capital rate. The decision rule for the IRR method is to abandon when the rate of return on abandonment value is less than the cost of capital. They also defined abandonment value. They describe it as the "net disposal value of the project that would be available to the company in either cash or cash savings"[3].

Robichek and Van Horne also began with the four following basic assumptions. They are:

1. A meaningful cost-of-capital rate exists.
2. There is no capital rationing.
3. All projects, existing as well as proposed, have the same degree of risk.
4. A meaningful, unique internal rate of return exists.

Robichek and Van Horne also proposed that the presence of significant abandonment value may reduce the "risk" of a project relative to that which would be obtained when the abandonment option is not included. Robichek and Van Horne demonstrated in their paper

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[2]Robichek, A. A., and J. C. Van Horne, 'Abandonment Value and Capital Budgeting." Journal of Finance, Vol. 22 (December 1967)

[3]Ibid

that if a project has a significant abandonment value, this value must be taken into consideration in the capital budgeting procedure.

Dyl and Long[4] expanded on Robichek and Van Horne's paper suggesting that "certain patterns of cash flows and/or abandonment values", when applied to the Robichek and Van Horne abandonment decision rule, produced a sub optimal decision. They proposed an alternative which gives optimal results.

Essentially Dyl and Long reviewed the problem and found in a specific example that even though the Robichek and Van Horne decision rule required abandonment in a specific period, holding the asset and abandoning at a later period produced a larger net present value. Therefore, the Robichek and Van Horne rule did not produce an optimal decision. They also did confirm an interesting fact that Robichek and Van Horne presented. That is, that including abandonment in capital budgeting will result in an expected internal rate of return greater that or equal to the non abandonment case. The Dyl and Long decision rule maximizes the net present value of the project.

Dyl and Long proposed the following decision rule. The analyst should calculate the maximum present value:

$$\max_{t+1 \leq a \leq n} P_{t \cdot a}$$

[4]Dyl, E. A., and H.W. Long. "Abandonment Value and Capital Budgeting." Journal of Finance, Vol. 24 (March 1969).

where

t = current period

a = any period of possible future abandonment

n = life of the project

That is the abandonment value in period a plus the expected values of the cash flows for the first a periods discounted to the present value of time "t". Then all a values are compared to each other and the maximum value is compared to the current abandonment value. With this rule n different PVs are calculated. If at time "t" the current abandonment value AV_t (abandonment value at time "t") is greater than $PV_{t \cdot a}$ the project should be abandoned. Dyl and Long also said that if this wasn't true, then the project should be held and abandoned at time a (which corresponds to the maximum $PV_{t \cdot a}$).

Robicheck and Van Horne replied in the same edition of the Journal of Finance[5] as the Dyl and Long article and acknowledged the omission they made but disagreed with part of Dyl and Long's decision rule. They said that due to the fact that future cash flows are uncertain it is not fair to say that if $AV_t \leq PV_{t \cdot a}$, the project should be abandoned in period "a". They felt that all this should tell the analyst is that the project should be held beyond period "t". They proposed that expectations probably will change between periods "t" and "a" and that

[5]Robichek, A. A., and J. C. Van Horne, 'Abandonment Value and Capital Budgeting: Reply." Journal of Finance, Vol. 24 (March 1969)

the project should be reevaluated before abandonment. They also proposed a slightly modified algorithm and decision rule.

The advantage of this revised method is all possible present values are not necessarily required. The only decision is whether to abandon at present time or hold till the future and then reevaluate.

O. Maurice Joy[6] later identified two capital budgeting problems that require different methods of analysis. Joy said that the revised Robichek and Van Horne model is good for one circumstance and the Dyl and Long model for the other. He said that in accept/reject (or hold/abandon) decisions when the project is not necessarily competing against another the Robichek and Van Horne method suffices for the analysis. However, when there are mutually exclusive projects, it is necessary to find the optimal present value to make sure that capital is optimally distributed.

Charles Bonini presented a "dynamic programming model for evaluating an investment project that includes abandonment options and for which the future cash flows are uncertain"[7]. What Bonini shows that when cash flows are uncertain, his procedure determines how far these cash flows can deviate before early abandonment should be considered. His model also proposed an analytical procedure for

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[6]Joy, O. M. "Abandonment Values and Abandonment Decisions." Journal of Finance, (September 1976)

[7]Bonini, C. P. "Capital Investment under Uncertainty with Abandonment Options." Journal of Financial and Quantitative Analysis, Vol. 12 (March 1977)

determination of the variability of the cash flows which he says is an indication of project risk.

Jack Gaumnitz and Douglas Emery[8] presented some refinements to the Robichek and Van Horne and Dyl and Long abandonment models. Specifically they gave considerable attention to the "like for like" replacement decision. Their reasoning here was that more and more business are being presented with this decision as technology quickly advances and assets are replaced by more efficient models. They propose that in this type of decision the alternative models can give conflicting recommendations regarding the year of replacement. They say that the model used should reflect the assumptions for each project. More than one model may be used by firms for different projects depending upon circumstances.

Gaumnitz and Emery presented a model which was a function of cash flows, initial project cost, and abandonment value. The model was then differentiated with respect to time, set equal to zero and solved for the cost of capital. This represented the time when net present value, NPV, was at its maximum (or mathematically, potentially at its minimum). The Gaumnitz and Emery model is presented below for the discrete cash flow, continuous discounting, case.

$$NPV = \sum_{t=1}^{\tau} f(t)\, e^{-kt} - C + AV\, e^{-kt}$$

[8]Gaumnitz, J. E., and D. R. Emery. "Asset Growth, Abandonment Value and the Replacement Decision of Like-For-Like Capital Assets." Journal of Financial and Quantitative Analysis, Vol. 15 (June 1980)

The Gaumnitz and Emery model result is:

$$k = \frac{f'(t) + AV_t'}{f(t) + AV_t}$$

The result is interpreted as, the asset is held for that length of time where the cash flow stream divided by the net cash flow the firm's cost of capital is equal to the rate of growth in the net cash flow. This time is then the expected optimal holding period beginning at time zero. The point is made here, that later events may result in a different optimal holding period.

Gaumnitz and Emery go on to analyze the replacement decision and the rate of return solution. They determine that the number of periods that maximizes the rate of return "r" is:

$$r = \frac{f'(t) + AV_t'}{f(t) + AV_t}$$

This holding period they say may or may not be equal to the one in the preceding example.

Gaumnitz and Emery apply these relationships in the "like for like" replacement decision. Their conclusion is that the replacement cycle should be based on either the rate of return model or the replacement net present value model. The actual model used should depend on the analysts judgement regarding the reinvestment rate.

Howe and McCabe did a similar analysis to Gaumnitz and Emery. They examined the pure abandonment case, the infinite cycle replacement, and the "N" cycle replacement. Their model for the pure abandonment case is similar to Gaumnitz and Emery's for the discrete case.

$$NPV(t) = \sum_{t=1}^{\tau} \frac{CF(t)}{(1+k)^t} - C + \frac{AV}{(1+k)^t}$$

and the continuous.

$$NPV(t) = \int_0^{\tau} CF(t)\exp^{(-kt)}dt - I + AV\exp^{(-kt)}$$

They then obtain the following equation after differentiation, setting derivative to zero and solving for k.

$$k = \frac{CF(t^*) + AV'(t^*)}{AV(t^*)}$$

Where, "t*" is the optimal abandonment time. In other words, the asset is held until the instantaneous rate of return of holding is equal to the cost of capital.

For the discrete case, a similar result is obtained.

$$k \geq \frac{CF(t^*+1) + AV'(t^*+1) - AV(t)}{AV(t^*)}$$

Chen and Moore[9] again present an analysis of abandonment similar to that of Bonini. In effect they say that cash flow and abandonment values are nearly never known with certainty. They present a method by which a Bayesian approach is made to model uncertainty with respect to the cash flows. In their specific case the

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[9]Chen, Son-Nan, Moore, William T. "Project Abandonment Under Uncertainty: A Bayesian Approach", The Financial Review, November 1983

Bayesian approach abandoned slightly earlier and more frequently than the classical approach.

Cox and Martin[10] examined the abandonment problem adding uncertainty in three variables: cash flows, terminal value of the asset and the opportunity cost of funds. They make an interesting point in their article that the asset acquisition and abandonment decision are really mirror images of each other. In other words, in the asset acquisition mode, the firm is trying to decide whether to invest capital in return for cash flows and a possible abandonment value in the future. In the abandonment case, the firm is trying to decide whether to forego the cash flows in return for the selling of the asset.

Summary

Through the years, the authors continually expanded on each others models. In some cases the model didn't change much but the way that the information from the model is used. Later authors did present different types of models.

Uncertainty was introduced by many authors due to the fact that none of the three main variables (cash flows, abandonment values, cost of capital) are never known with certainty especially in mid to long term future. The availability of computers in years allows many of these techniques to be practically used. For the most part though, the

[10]Cox Jr., S. H., Martin, J. D., "Abandonment Value and Capital Budgeting Under Uncertainty." Journal of Economics and Business, Vol. 35, No. 3/4, August 1983

uncertainty was only introduced in the cash flows and abandonment value but not with the cost of capital.

With respect to the practicality of use of these models in real applications, the authors seem to gloss over this as being something for the reader to figure out for himself.

Chapter III

Model Design

The models presented in the literature bring forth some good ideas regarding the subject of abandonment in capital budgeting. However in some cases the models cannot be practically applied because of the fact that things change in the future and the analyst cannot really make future decisions such as, "we're going to abandon this asset in five years". In reality the only real decision he can make is whether or not he will abandon this asset now or continue to use it. Future abandonment may be useful in those cases where the analyst is trying to do some planning. However, due to the dynamics of the world markets today an analysis still needs to be made at the time the abandonment decision will be made.

The most obvious point brought out is the abandonment decision is quite similar to the capital budgeting decision only in the opposite direction. Often the asset has been purchased, the real decision is whether the firm would be better off to sell the asset and reinvest the money somewhere else at a higher return or hold the asset.

The new tax laws passed in 1986 prompted many managers to review the status of their assets. Real estate was particularly affected due to changes in the depreciation rules and the abilities to offset normal income with passive losses. Real estate values began to decrease and many people will be analyzing their income producing assets.

The model presented by Howe and McCabe gives the decision maker a rate of return. The model is presented as follows:

$$\frac{CF(t+1) + AV(t+1) - AV(t)}{AV(t)}$$

where "t" is the current time period. Using their model the return is then compared to the cost of capital, and, if the return is less than the cost of capital, the asset should be abandoned.

The model, however, has some faults. The model may give false signals with respect to the abandonment decision. In many cases an asset or project may start off with a low rate of return early in it's life and then rise to an above average return. If one abandoned the asset due to an early calculation, a potentially good asset is abandoned. The Howe & McCabe model is easy to calculate and takes into account the abandonment value. The analyst calculates the rate of holding the asset one more period.

The Howe & McCabe model is expanded to take into account the fact that cash flows do vary in different ways over time and these variations need to be accounted for to get a valid decision. Model 1, developed for this study, includes changes in cash flows and abandonment values over time.

Several definitions are presented for clarification. First, cash flows are received at the end of the period, and second, the abandonment value is determined at the beginning of the period. In its simplest form Howe and McCabe`s model is extended to average cash flows and changes in abandonment value over the life of the asset.

Model 1 is presented as:

$$\frac{\dfrac{\left(\sum_{t=1}^{n} CF_t\right)}{n} + \dfrac{\left(AV_n - AV_1\right)}{(n-1)}}{AV_1}$$

where "n" is the final year of life of the asset. (Remember "n-1" is used because abandonment value is determined at the beginning of the period.)

Model 1 calculates an average return on abandonment value over the life of the asset. The decision rule is the same as the Howe and McCabe model. Compare the calculated return to the cost of capital and abandon if the calculated rate is lower than the cost of capital.

Model 1 is still easy to calculate and is not as short sighted as Howe and McCabe's model because it does average out cash flows and abandonment values. However, the time value of money is not included as part of the analysis.

Once again, the model is expanded. This time it is expanded to include the time value of money. Instead of simply averaging, the present values of all future cash flows from the current period until the final year (the end of the assets life) are averaged. The current cost of capital is used as the discount rate to determine the present values. The present value of the final abandonment value is used to evaluate the change in abandonment values over time and averaged over the number of years in the analysis. These two figures are added together and divided into the current abandonment value. Model 2 is presented as follows:

$$\frac{\dfrac{\left(\sum_{t=1}^{n} \dfrac{CF_t}{(1+k)^t}\right)}{n} + \dfrac{\left(\dfrac{AV_n}{(1+k)^{n-1}} - AV_1\right)}{(n-1)}}{AV_1}$$

Once again the decision rule remains the same. Compare the calculated return to the firms cost of capital and abandon if the calculated rate is less than the cost of capital.

Model 2 takes care of the time value of money by discounting the cash flows and final abandonment value. This is particularly important in very long term projects. On the negative side, the reinvestment rate is assumed at the cost of capital rate. It is important to remember here that the future cash flows will be invested at the current cost of capital.

The sensitivity of this calculation to the reinvestment rate is examined in the next section.

All three models were subjected to a sensitivity analysis using a spread sheet program and personal computer. A hypothetical case was created where an asset was purchased for $10,000 and projected to have a life of seven years. The asset is being evaluated for potential abandonment in year two of its life. For simplicity the current year is considered year one and other years adjusted accordingly.

The analysis involves varying cash flows, abandonment values, and costs of capital to see the affect on the abandonment decision. The chart below identifies which variables (and how much) were manipulated for each case. For example, Case 1 involves increasing the cash flows 20 percent and increasing the abandonment value 20 percent annually. Specifically, returns were calculated for each of the years in the future and compared to the assumed cost of capital of eight percent. For the sensitivity analysis, returns were calculated at varying costs of capital for Model 2. Figure 2 below summarizes the nine cases that will be considered in this analysis.

Abandonment Value \ Cash Flows	Increasing 20%	Constant	Decreasing 20%
Increasing 20%	Case 1	Case 2	Case 3
Constant	Case 4	Case 5	Case 6
Decreasing 20%	Case 7	Case 8	Case 9

Figure 2
Summary of Nine Cases Used in Analysis
Contrasting Changes in Cash Flows and Abandonment Values

To facilitate analysis, a summary spread sheet is formed that includes results from all of the cases. Charts can then be developed that will graphically summarize the results. All of the spread sheets for the individual cases are included in the appendix.

Chapter IV

Analysis of Models

The results of the cases can be analyzed in two ways. Holding the abandonment value constant and varying cash flows or vice versa. Utilizing the former, charts were created from a summary spread sheet which contained information from all of the cases. This allows comparison of the three models while holding one variable constant. For cases one through nine, three charts are produced and are included below. As expected when the cash flows remain constant the results for Model 1 and Howe and McCabe's model are identical. This occurs because Howe and McCabe's model takes into account changing abandonment value (constant changes - not fluctuating) but not changing cash flows. If the abandonment value were fluctuating between beginning and final values, Model 1's results would not change but Howe and McCabe's return would be different. Therefore when cash flows are increasing, Model 1 calculates a return higher than Howe and McCabe's model and when they are decreasing, a lower return.

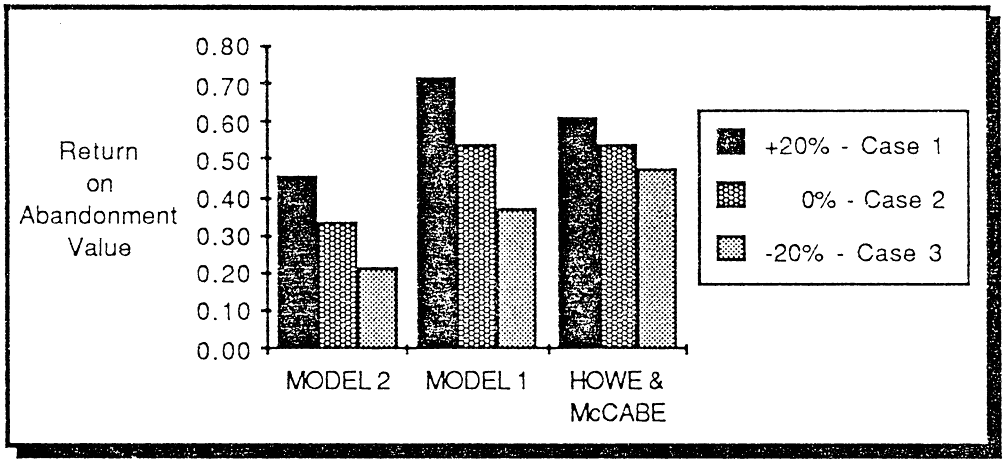

Figure 3
Summary of Cases 1, 2 & 3
Abandonment Value Increasing at 20%
Cash Flows varying from -20% to +20%

Figure 3 depicts a summary of cases 1, 2 & 3 where the abandonment is increasing in all three cases and cash flows are varied from decreasing at 20% to increasing at 20%. It is evident that the increasing abandonment value is compensating for the cash flows and there is only a slight change in the return on abandonment values for any model. Model 1 calculates a higher return for Case 1 followed by Howe & McCabe. Model 2 provides the most conservative return. However, when cash flows are decreasing, as in Case 3, the Howe and McCabe model has a higher return. This occurs because when cash flows are increasing (or decreasing), Model 1 averages the cash flows instead of using absolute changes.

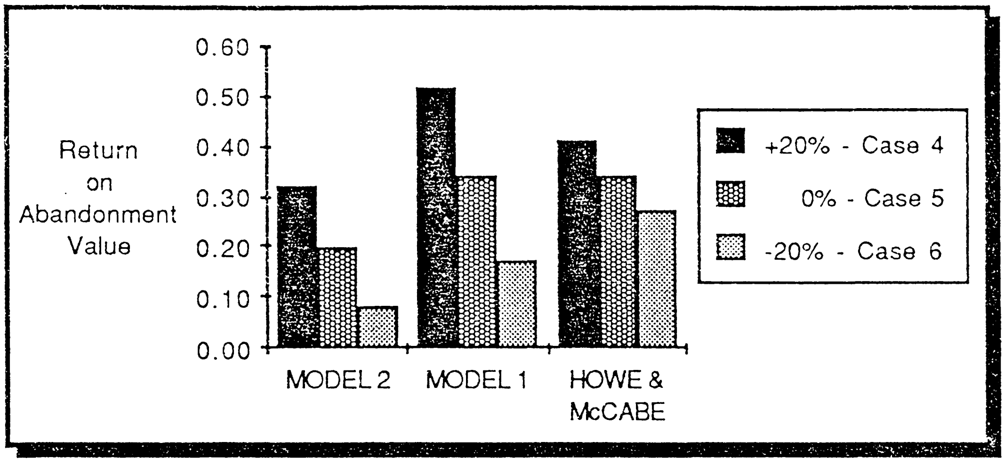

Figure 4
Summary of Cases 4, 5 & 6
Abandonment Value Constant
Cash Flows varying from -20% to +20%

Figure 4 depicts a summary of cases 4, 5 & 6 where the abandonment is constant in all three cases and cash flows are varied from decreasing at 20% to increasing at 20%. Here the constant abandonment value does not compensate as much for the cash flows and there is only a moderate change in the return on abandonment values for any model between all three cases. Again, Model 1 calculates the highest return for Case 4. Howe and McCabe's model calculates a higher return for Case 6 where cash flows are decreasing. Model 2 still provides the most conservative returns in all cases.

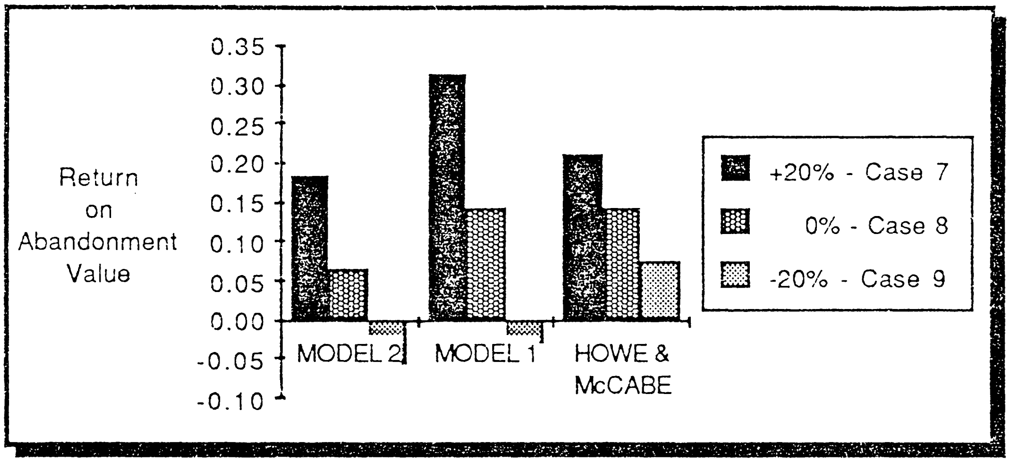

Figure 5
Summary of Cases 7, 8 & 9
Abandonment Value Decreasing at 20%
Cash Flows varying from -20% to +20%

Figure 5 depicts a summary of cases 7, 8 & 9 where the abandonment is decreasing in all three cases and cash flows are varied from decreasing at 20% to increasing at 20%. Now the decreasing abandonment value is depressing the return on abandonment value calculations for all models. If we look back to our assumption that the cost of capital is eight percent, then abandonment is indicated for Cases 8 and 9 with Model 2 and indicated for Case 9 with Model 1.

In all cases, however, Model 2 calculates a return lower than either of the other two models. This seems reasonable because present values are used which result in lower values for cash values and abandonment value in the final year after discounting.

Table 1
Case Summary for All Models
Year 1 Results

	CASH FLOWS	ABANDONMENT VALUE	MODEL 2	MODEL 1	HOWE & McCABE
CASE 1	20%	20%	0.46	0.72	0.61
CASE 2	0%	20%	0.34	0.54	0.54
CASE 3	-20%	20%	0.22	0.37	0.48
CASE 4	20%	0%	0.32	0.52	0.41
CASE 5	0%	0%	0.20	0.34	0.34
CASE 6	-20%	0%	0.08	0.17	0.28
CASE 7	20%	-20%	0.19	0.32	0.21
CASE 8	0%	-20%	0.06	0.14	0.14
CASE 9	-20%	-20%	-0.06	-0.03	0.08

Table 1 Summarizes the return on abandonment calculations for year 1 for all nine cases. Utilizing the decision rule to compare this return to the assumed cost of capital, (8%), we can note that Model 2, Case 6 indicates a borderline abandonment because the return is less than the cost of capital. With cases 8 & 9, however, Model 2 indicates abandonment. Case 8 shows abandonment with Model 2 only. The other models indicate that the asset should be retained. It is inthese cases that different answers are received depending on which model is used.

Table 2
Summary of Model 2
Calculated Rate of Return on Abandonment Value
As a Function of Discount Rate (Cost of Capital)
Year 1 Results

Discount Rate	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8	CASE 9
0.08	0.46	0.34	0.22	0.32	0.20	0.08	0.19	0.06	-0.06
0.09	0.43	0.32	0.20	0.30	0.19	0.07	0.17	0.06	-0.06
0.10	0.41	0.30	0.19	0.28	0.17	0.06	0.16	0.05	-0.06
0.11	0.39	0.28	0.17	0.27	0.16	0.05	0.15	0.04	-0.06
0.12	0.36	0.26	0.16	0.25	0.15	0.05	0.14	0.04	-0.07
0.13	0.34	0.25	0.15	0.24	0.14	0.04	0.13	0.03	-0.07
0.14	0.33	0.23	0.14	0.22	0.13	0.03	0.12	0.02	-0.07
0.15	0.31	0.22	0.12	0.21	0.12	0.03	0.11	0.02	-0.07
0.16	0.29	0.20	0.11	0.19	0.11	0.02	0.10	0.01	-0.08

Table 3
Model 2 Sensitivity
Change in Calculated Rate of Return on Abandonment Value
Divided by Change in Discount Rate (Cost of Capital)

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8	CASE 9
Sensitivity	-2.11	-1.69	-1.28	-1.60	-1.18	-0.77	-1.09	-0.67	-0.26

There are several ways to look at the sensitivity of these models. Sensitivity can be defined as the change in calculated return for unit change in cash flow, holding abandonment value constant. In this case, Model 2 is less sensitive to changes in cash flows than Model 1 but more sensitive than Howe and McCabe. Looking at it the other way, change in calculated return for unit change in abandonment value, Model 2 is less sensitive than both models. In fact, as expected, holding changes in cash flow constant, Model 1 and Howe and McCabe both produce a rate of return that increases one percent for each one percent change in abandonment value. This would only be expected when the abandonment value is changing at a constant rate.

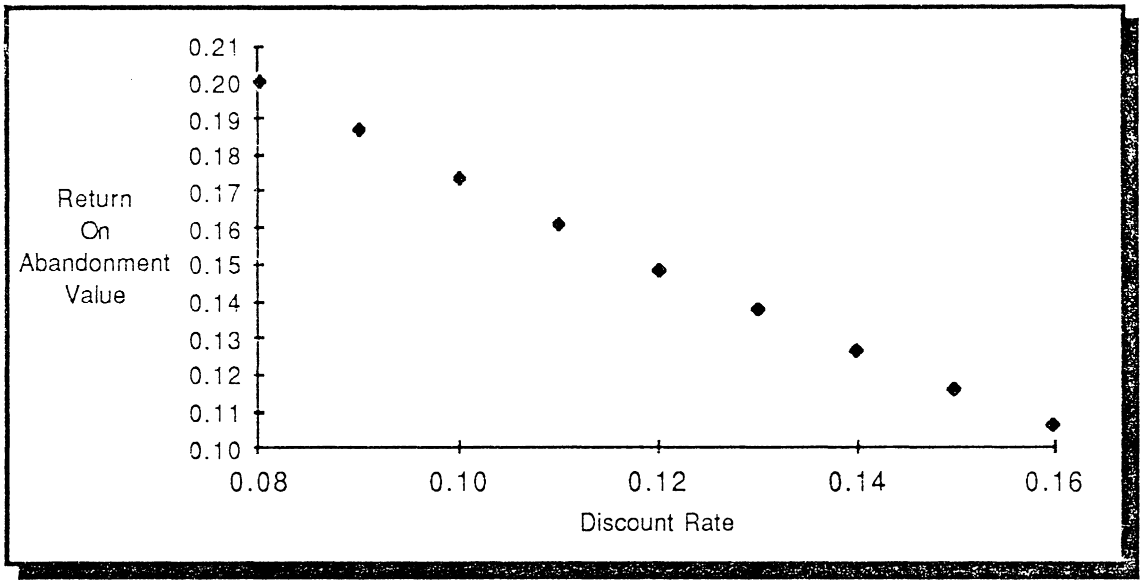

Figure 6
Model 2 Calculated Rate of Return
Verses Discount Rate (Cost of Capital)
From Case 5
Constant Cash Flow
Constant Abandonment Value

The sensitivity of the calculated return as a function of the discount rate varies from case to case. The sensitivity is defined here as the change in return divided by the change in discount rate. In general the sensitivity is highest (due to compounding effect) when both cash flows and abandonment values are increasing and lowest when both are decreasing. Figure 6 shows how the calculated return varies as a function of the discount rate (cost of capital) used for Case 5. Here, the slope is -1.18. It is downward sloping as expected because as the discount rate increases, the present value of the cash flows and final abandonment value decreases, thus, decreasing the value of the numerator in Model 2. Table 3 also gives the results of this sensitivity calculation. A similar pattern is exhibited by all of the other cases.

Chapter V

Summary and Conclusions

Table 1 contains a summary of all of the cases. The assumption has been made that the cost of capital (discount rate) is eight percent for this summary.

The most important question on this entire paper is when should the firm abandon the asset. Utilizing our assumption that the cost of capital is eight percent and remembering that the decision rule is to compare the calculated rate of return on abandonment to the cost of capital, Case 8 indicates abandonment with Model 2 but not with Model 1. In Case 9, McCabe and Howe's model indicates a borderline hold while Models 1 and 2 both indicate abandonment.

It is these borderline cases where the use of the proper model can make a big difference in an accept or reject decision. In the cases examined here, Howe and McCabe never indicates an abandonment. The more sensitive Models 1 and 2 are required to make the final decision. Figure 7 summarizes the good points and the bad points of the models.

Abandonment Models			
	Howe & McCabe Model	Model 1	Model 2
Equation	$\dfrac{CF(t+1) + AV(t+1) - AV(t)}{AV(t)}$	$\dfrac{\dfrac{\left(\sum_{t=1}^{n} CF_t\right)}{n} + \dfrac{\left(AV_n - AV_1\right)}{(n-1)}}{AV_1}$	$\dfrac{\dfrac{\left(\sum_{t=1}^{n} \dfrac{CF_t}{(1+k)^t}\right)}{n} + \dfrac{\left(\dfrac{AV_n}{(1+k)^{n-1}} - AV_1\right)}{(n-1)}}{AV_1}$
Model Description	Instantaneous rate of return to hold asset one more period.	Rate of Return on abandonment value.	Rate of Return on abandonment value with discounted cash flows and discounted final abandonment value.
Good Features	Easy to calculate. Takes into account changing AV's.	Averages out bad cash flow years. Averages abandonment value over the life of the asset.	Averages out bad cash flow years. Takes into account time value of money on cash flows and final abandonment value.
Bad Features	Short term viewpoint. May over react (give bad indications when AV changes fast or cash flows go bad in one period.	Does not takes into account time value of money.	Reinvestment rate problem.

Figure 7
Summary of Features for all Abandonment Models

It is probably safe to say that if the Howe and McCabe model indicates abandonment, Models 1 and 2 will also indicate the same. Especially since Model 2 is always more conservative than the others.

Limitations

One of the main limitations of the model as with any capital budgeting problem is the forecast of cash flows and abandonment value. Many of the variables discussed in the introduction can really affect the assumptions made to determine the cash flows and abandonment values. Prediction of those events is impossible.

It is the very fact that these things do change that causes us to not only evaluate the future cash flows and abandonment value but also make the decision whether or not to abandon the asset or keep it. It is hoped that this paper provides the analyst with a tool to evaluate the question and make the proper decision.

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Appendix

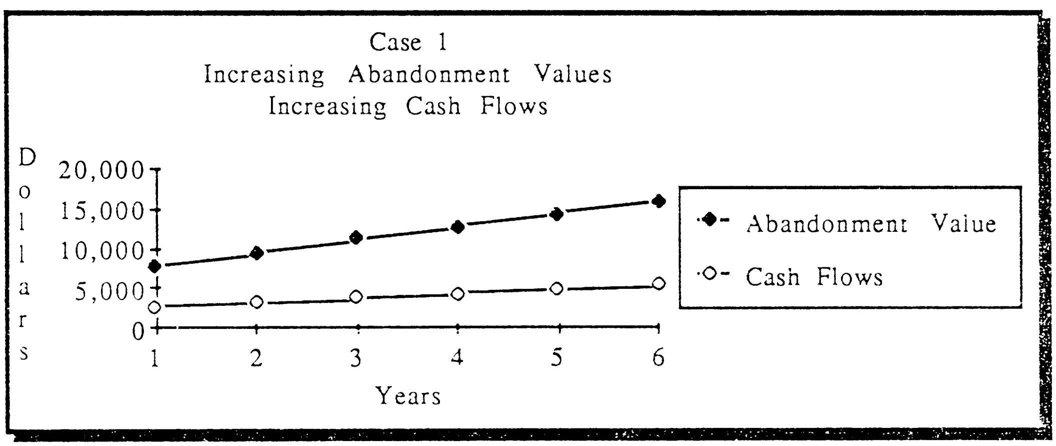
Table A-1
Case 1
Cash Flows Increasing at 20 Percent.
Abandonment Value Increasing at 20 Percent

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	3,300	3,850	4,400	4,950	5,500
Abandonment Value		8,000	9,600	11,200	12,800	14,400	16,000

Abandonment Model 2						Discount rate
Return on AV	0.46	0.42	0.39	0.37	0.35	0.08
	0.43	0.39	0.37	0.35	0.34	0.09
	0.41	0.37	0.35	0.33	0.32	0.10
	0.39	0.35	0.33	0.32	0.31	0.11
	0.36	0.34	0.32	0.31	0.30	0.12
	0.34	0.32	0.30	0.29	0.28	0.13
	0.33	0.30	0.29	0.28	0.27	0.14
	0.31	0.28	0.27	0.26	0.26	0.15
	0.29	0.27	0.26	0.25	0.25	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	18,501	17,231	15,309	12,684	9,299
Average PV CF	3,083	3,446	3,827	4,228	4,649
PV AV	10,889	11,760	12,701	13,717	14,815
Change in AV	2,889	2,160	1,501	917	415
Average Change AV	578	540	500	459	415
Return on AV	0.46	0.42	0.39	0.37	0.35



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.61	0.57	0.54	0.51	0.49

Abandonment Model 1

0.72	0.63	0.56	0.51	0.47

Table A - 2

Case 2

Cash Flows Constant

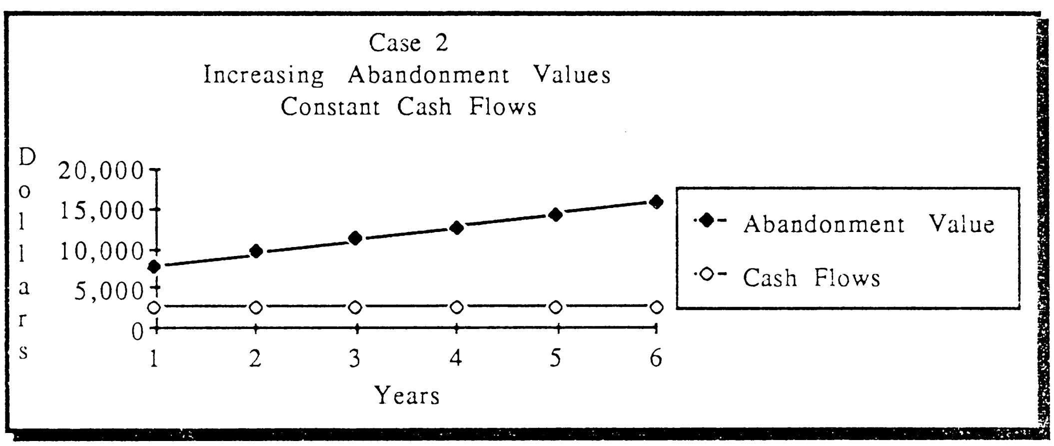
Abandonment Value Increasing at 20 Percent

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,750	2,750	2,750	2,750	2,750
Abandonment Value		8,000	9,600	11,200	12,800	14,400	16,000

Abandonment Model 2						Discount rate
Return on AV	0.34	0.29	0.25	0.22	0.20	0.08
	0.32	0.27	0.23	0.21	0.19	0.09
	0.30	0.25	0.22	0.19	0.18	0.10
	0.28	0.24	0.21	0.18	0.16	0.11
	0.26	0.22	0.19	0.17	0.15	0.12
	0.25	0.21	0.18	0.16	0.14	0.13
	0.23	0.19	0.17	0.15	0.13	0.14
	0.22	0.18	0.16	0.14	0.12	0.15
	0.20	0.17	0.14	0.13	0.11	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	12,713	10,980	9,108	7,087	4,904
Average PV CF	2,119	2,196	2,277	2,362	2,452
PV AV	10,889	11,760	12,701	13,717	14,815
Change in AV	2,889	2,160	1,501	917	415
Average Change AV	578	540	500	459	415
Return on AV	0.34	0.29	0.25	0.22	0.20



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.54	0.45	0.39	0.34	0.30

Abandonment Model 1

0.54	0.45	0.39	0.34	0.30

Table A - 3

Case 3

Cash Flows Decreasing at 20 Percent.

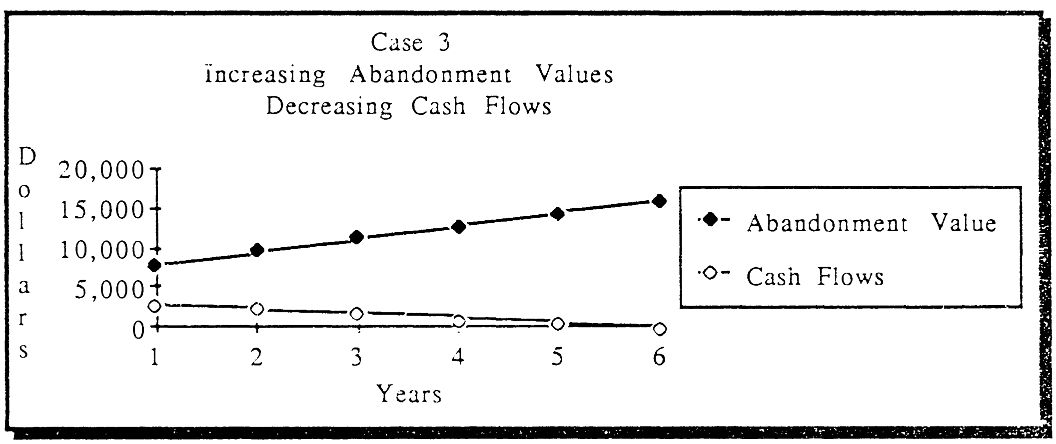
Abandonment Value Increasing at 20 Percent

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,200	1,650	1,100	550	0
Abandonment Value		8,000	9,600	11,200	12,800	14,400	16,000

Abandonment Model 2						Discount rate
Return on AV	0.22	0.15	0.11	0.07	0.05	0.08
	0.20	0.14	0.10	0.06	0.04	0.09
	0.19	0.13	0.09	0.05	0.03	0.10
	0.17	0.12	0.08	0.04	0.02	0.11
	0.16	0.11	0.07	0.04	0.01	0.12
	0.15	0.10	0.06	0.03	0.00	0.13
	0.14	0.09	0.05	0.02	-0.01	0.14
	0.12	0.08	0.04	0.01	-0.02	0.15
	0.11	0.07	0.03	0.00	-0.03	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	6,925	4,729	2,907	1,490	509
Average PV CF	1,154	946	727	497	255
PV AV	10,889	11,760	12,701	13,717	14,815
Change in AV	2,889	2,160	1,501	917	415
Average Change AV	578	540	500	459	415
Return on AV	0.22	0.15	0.11	0.07	0.05



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.48	0.34	0.24	0.17	0.11

Abandonment Model 1

0.37	0.28	0.22	0.17	0.13

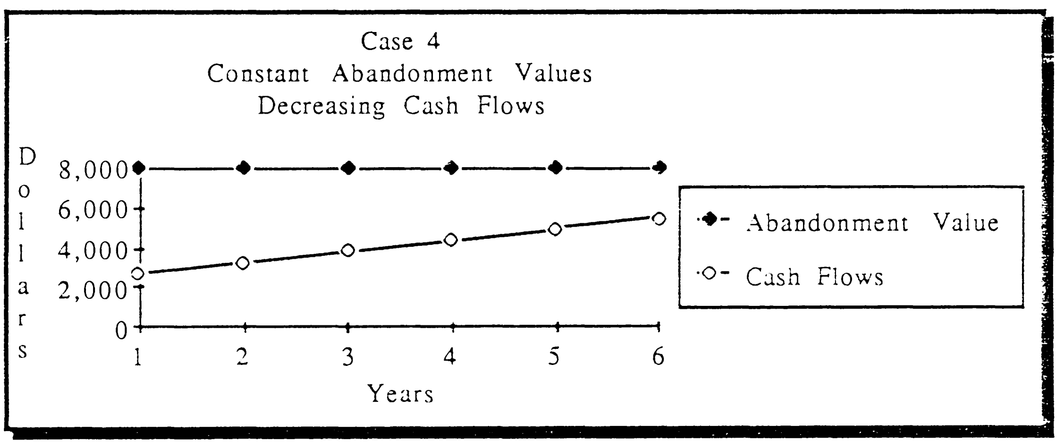
Table A - 4
Case 4
Cash Flows Increasing at 20 Percent.
Abandonment Value Constant

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	3,300	3,850	4,400	4,950	5,500
Abandonment Value		8,000	8,000	8,000	8,000	8,000	8,000

Abandonment Model 2						Discount rate
Return on AV	0.32	0.36	0.41	0.46	0.51	0.08
	0.30	0.35	0.39	0.44	0.49	0.09
	0.28	0.33	0.37	0.42	0.47	0.10
	0.27	0.31	0.36	0.41	0.46	0.11
	0.25	0.29	0.34	0.39	0.44	0.12
	0.24	0.28	0.32	0.37	0.43	0.13
	0.22	0.26	0.31	0.36	0.41	0.14
	0.21	0.25	0.29	0.34	0.40	0.15
	0.19	0.24	0.28	0.33	0.38	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	18,501	17,231	15,309	12,684	9,299
Average PV CF	3,083	3,446	3,827	4,228	4,649
PV AV	5,445	5,880	6,351	6,859	7,407
Change in AV	-2,555	-2,120	-1,649	-1,141	-593
Average Change AV	-511	-530	-550	-571	-593
Return on AV	0.32	0.36	0.41	0.46	0.51



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.41	0.48	0.55	0.62	0.69

Abandonment Model 1

0.52	0.55	0.58	0.62	0.65

Table A - 5
Case 5
Cash Flows Constant.
Abandonment Value Constant

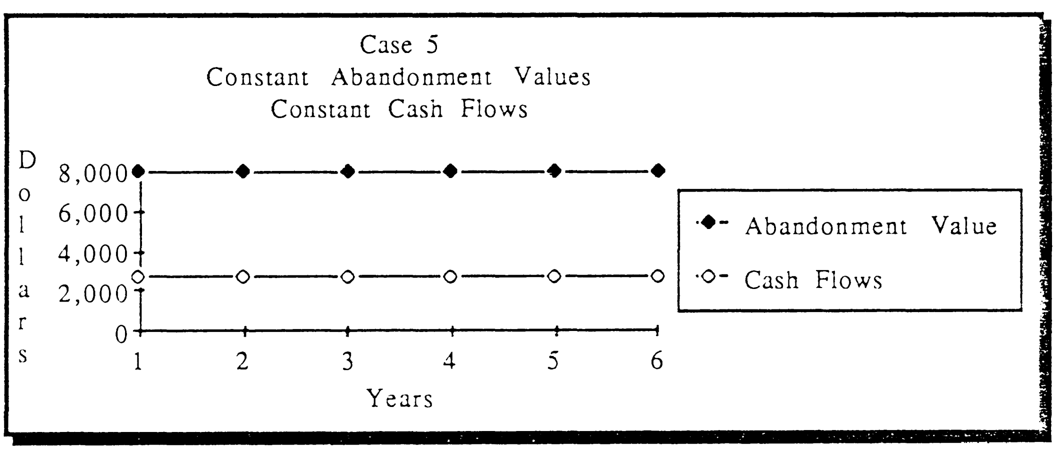
	0	1	2	3	4	5	6
Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,750	2,750	2,750	2,750	2,750
Abandonment Value		8,000	8,000	8,000	8,000	8,000	8,000

Abandonment Model 2

						Discount rate
Return on AV	0.20	0.21	0.22	0.22	0.23	0.08
	0.19	0.19	0.20	0.21	0.22	0.09
	0.17	0.18	0.19	0.20	0.21	0.10
	0.16	0.17	0.18	0.19	0.20	0.11
	0.15	0.16	0.16	0.17	0.18	0.12
	0.14	0.15	0.15	0.16	0.17	0.13
	0.13	0.13	0.14	0.15	0.16	0.14
	0.12	0.12	0.13	0.14	0.15	0.15
	0.11	0.11	0.12	0.13	0.14	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	12,713	10,980	9,108	7,087	4,904
Average PV CF	2,119	2,196	2,277	2,362	2,452
PV AV	5,445	5,880	6,351	6,859	7,407
Change in AV	-2,555	-2,120	-1,649	-1,141	-593
Average Change AV	-511	-530	-550	-571	-593
Return on AV	0.20	0.21	0.22	0.22	0.23



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.34	0.34	0.34	0.34	0.34

Abandonment Model 1

0.34	0.34	0.34	0.34	0.34

Table A - 6

Case 6

Cash Flows Decreasing at 20 Percent.

Abandonment Value Constant

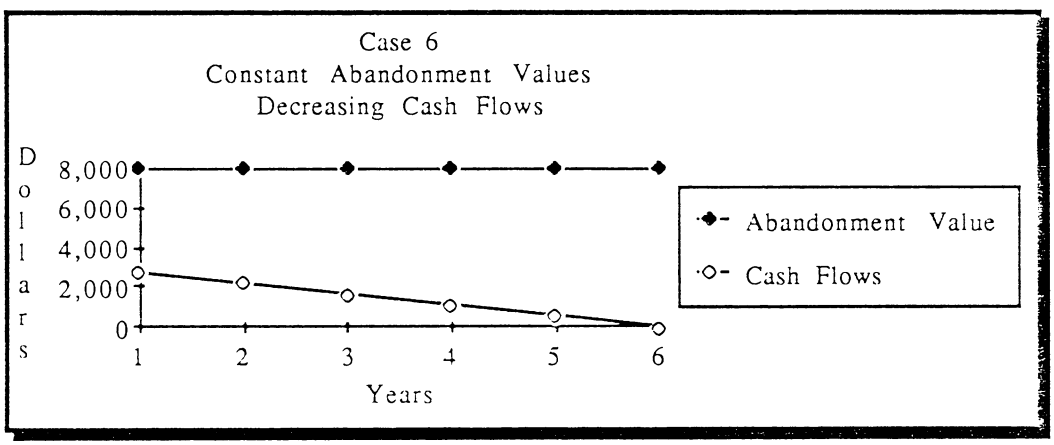
Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,200	1,650	1,100	550	0
Abandonment Value		8,000	8,000	8,000	8,000	8,000	8,000

Abandonment Model 2

						Discount rate
Return on AV	0.08	0.05	0.02	-0.01	-0.04	0.08
	0.07	0.04	0.01	-0.02	-0.05	0.09
	0.06	0.03	0.01	-0.03	-0.06	0.10
	0.05	0.03	0.00	-0.03	-0.07	0.11
	0.05	0.02	-0.01	-0.04	-0.08	0.12
	0.04	0.01	-0.02	-0.05	-0.08	0.13
	0.03	0.00	-0.03	-0.06	-0.09	0.14
	0.03	0.00	-0.03	-0.06	-0.10	0.15
	0.02	-0.01	-0.04	-0.07	-0.11	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	6,925	4,729	2,907	1,490	509
Average PV CF	1,154	946	727	497	255
PV AV	5,445	5,880	6,351	6,859	7,407
Change in AV	-2,555	-2,120	-1,649	-1,141	-593
Average Change AV	-511	-530	-550	-571	-593
Return on AV	0.08	0.05	0.02	-0.01	-0.04



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.28	0.21	0.14	0.07	0.00

Abandonment Model 1

0.17	0.14	0.10	0.07	0.03

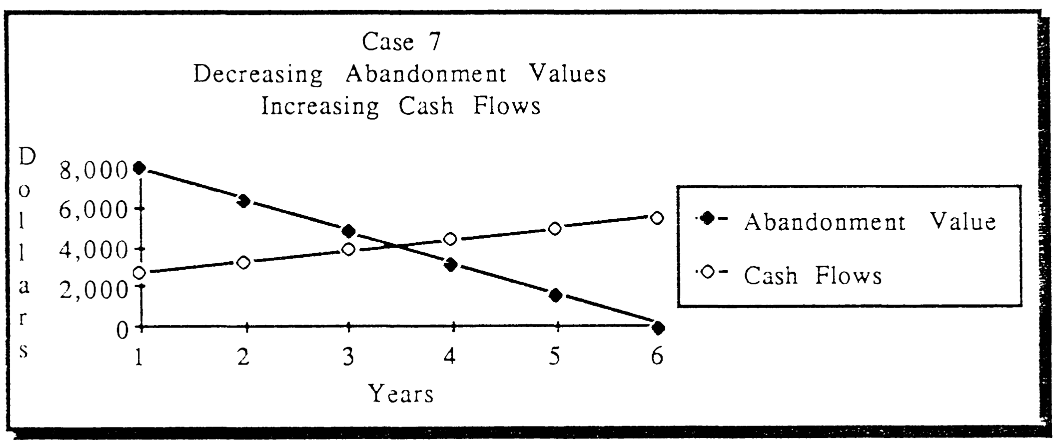
Table A - 7
Case 7
Cash Flows Increasing at 20 Percent.
Abandonment Value Decreasing at 20 Percent

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	3,300	3,850	4,400	4,950	5,500
Abandonment Value		8,000	6,400	4,800	3,200	1,600	0

Abandonment Model 2						Discount rate
Return on AV	0.19	0.29	0.46	0.82	1.91	0.08
	0.17	0.27	0.45	0.80	1.87	0.09
	0.16	0.26	0.43	0.77	1.83	0.10
	0.15	0.24	0.41	0.75	1.79	0.11
	0.14	0.23	0.39	0.73	1.75	0.12
	0.13	0.22	0.38	0.71	1.71	0.13
	0.12	0.21	0.36	0.69	1.68	0.14
	0.11	0.19	0.35	0.67	1.64	0.15
	0.10	0.18	0.33	0.65	1.61	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	18,501	17,231	15,309	12,684	9,299
Average PV CF	3,083	3,446	3,827	4,228	4,649
PV AV	0	0	0	0	0
Change in AV	-8,000	-6,400	-4,800	-3,200	-1,600
Average Change AV	-1,600	-1,600	-1,600	-1,600	-1,600
Return on AV	0.19	0.29	0.46	0.82	1.91



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.21	0.35	0.58	1.05	2.44

Abandonment Model 1

0.32	0.44	0.64	1.05	2.27

Table A - 8
Case 8
Cash Flows Constant
Abandonment Value Decreasing at 20 Percent

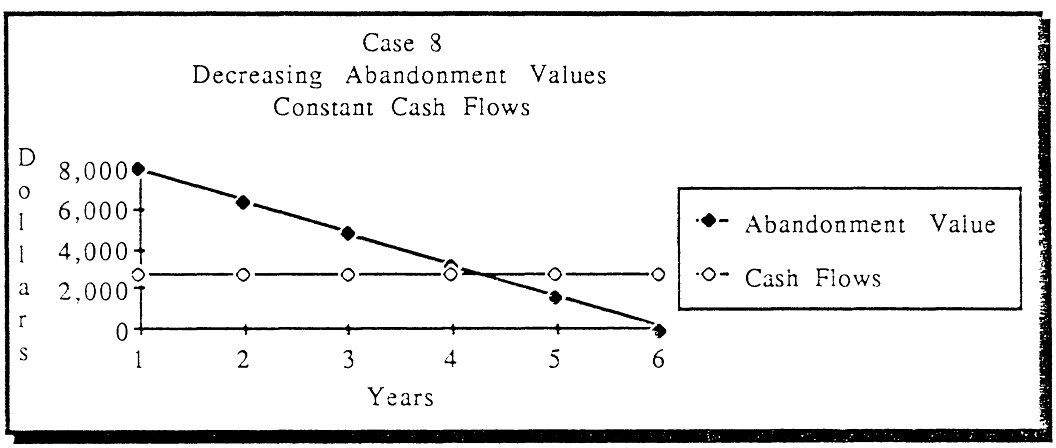
Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,750	2,750	2,750	2,750	2,750
Abandonment Value		8,000	6,400	4,800	3,200	1,600	0

Abandonment Model 2

						Discount rate
Return on AV	0.06	0.09	0.14	0.24	0.53	0.08
	0.06	0.08	0.13	0.23	0.51	0.09
	0.05	0.08	0.12	0.21	0.49	0.10
	0.04	0.07	0.11	0.20	0.47	0.11
	0.04	0.06	0.10	0.19	0.45	0.12
	0.03	0.05	0.09	0.18	0.43	0.13
	0.02	0.05	0.08	0.17	0.42	0.14
	0.02	0.04	0.08	0.15	0.40	0.15
	0.01	0.03	0.07	0.14	0.38	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	12,713	10,980	9,108	7,087	4,904
Average PV CF	2,119	2,196	2,277	2,362	2,452
PV AV	0	0	0	0	0
Change in AV	-8,000	-6,400	-4,800	-3,200	-1,600
Average Change AV	-1,600	-1,600	-1,600	-1,600	-1,600
Return on AV	0.06	0.09	0.14	0.24	0.53



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.14	0.18	0.24	0.36	0.72

Abandonment Model 1

0.14	0.18	0.24	0.36	0.72

Table A - 9

Case 9

Cash Flows Decreasing at 20 Percent.

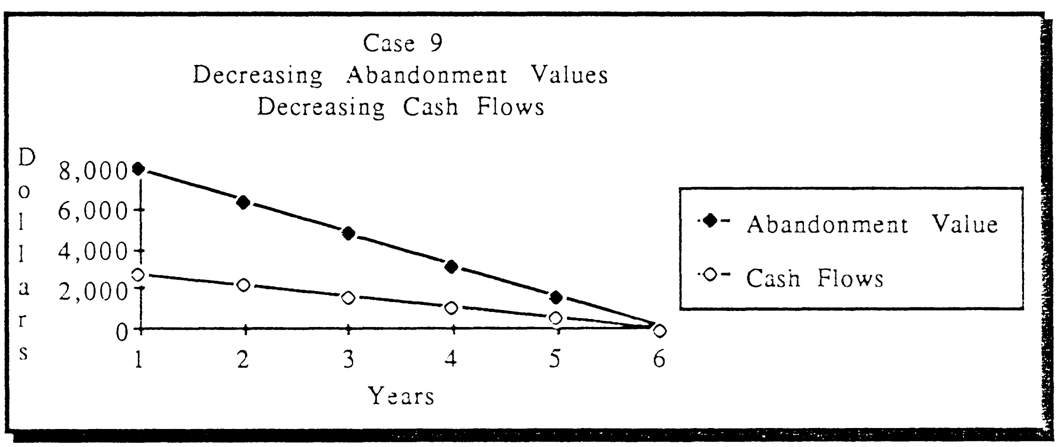
Abandonment Value Decreasing at 20 Percent

Year	0	1	2	3	4	5	6
Cash Flow	-10,000	2,750	2,200	1,650	1,100	550	0
Abandonment Value		8,000	6,400	4,800	3,200	1,600	0

Abandonment Model 2						Discount rate
Return on AV	-0.06	-0.10	-0.18	-0.34	-0.84	0.08
	-0.06	-0.10	-0.18	-0.35	-0.84	0.09
	-0.06	-0.11	-0.19	-0.35	-0.84	0.10
	-0.06	-0.11	-0.19	-0.35	-0.85	0.11
	-0.07	-0.11	-0.19	-0.35	-0.85	0.12
	-0.07	-0.11	-0.19	-0.35	-0.85	0.13
	-0.07	-0.12	-0.19	-0.36	-0.85	0.14
	-0.07	-0.12	-0.20	-0.36	-0.85	0.15
	-0.08	-0.12	-0.20	-0.36	-0.85	0.16

Detailed Calculations for Model 2 (Uses discount rate of 8%)

PV Cash Flow	6,925	4,729	2,907	1,490	509
Average PV CF	1,154	946	727	497	255
PV AV	0	0	0	0	0
Change in AV	-8,000	-6,400	-4,800	-3,200	-1,600
Average Change AV	-1,600	-1,600	-1,600	-1,600	-1,600
Return on AV	-0.06	-0.10	-0.18	-0.34	-0.84



Howe & McCabe Model - Instantaneous return to hold asset one more period.

0.08	0.01	-0.10	-0.33	-1.00

Abandonment Model 1

-0.03	-0.08	-0.16	-0.33	-0.83

VITA

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Candidate for the Degree of

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Major Field: Business Administration

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Personal Data: Born in Urbana, Illinois, May 8, 1956, the son of Robert and Alyce Konen.

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