



OLD ASSETS NEVER DIE

In fact, of course, few assets are immortal. For practical purposes, this may be the case for, land, but most other forms of assets become physically inoperable over time and must be replaced or substantially renewed to remain operationally viable. For most assets, their life cycle is a function of: 1) physical deterioration due to time or use, and/or 2) technological advancements which render an item obsolete. For example, technological improvements in the food processing sector of our agribusiness industry have caused existing plants and equipment to become obsolete despite their young age. More commonly, however, it is a combination of time, use, and gradual technological advances which shorten the expected life of an asset. The firm which refuses to replace an obsolete asset on the basis that it has not yet been fully depreciated will likely suffer from artificially high annual operating costs. Similarly, the firm which becomes so enamored with the advances in automation that it replaces assets prematurely must also suffer the high cost consequences.

Whether or not to replace an asset in your business firm represents an important decision. Moreover, it is a decision which must be made more frequently than you probably are aware of. For example, ask yourself how often during the past week have you talked with a salesman - any salesman - and decided. not to purchase his merchandise? Each decision not to purchase represents a replacement decision.

The objective of this paper is to outline asset replacement strategy. A series of examples will be presented and used to illustrate proper managerial analysis. The Terborgh system of replacement strategy* will be described. Tax savings from depreciation will be deleted from the discussion to simplify, as much as possible, a complex area.

Net Productivity

I shall define the net productivity of an asset (e.g., an item of plant equipment) as the value added to a product by the use of the asset less the asset's operating cost. In the agribusiness industry, the straight-line method of asset depreciation is most common. This method assumes that an asset will have some life (e.g., ten year;), will continue to demonstrate a constant net productivity from the day of its purchase until the end of the tenth year, and then suddenly become worthless (save any salvage value). In fact, the use of this method is wrong. Its only attribute is its simplicity. The inherent assumption violates common sense and practical experience. Anyone who has ever owned an automobile knows that net productivity declines at an irregular rate as an asset gets older. There are three reasons for this decline:

1. The value added by an asset decreases with age if for no other reason than increased downtime due to mechanical failures.

* G. Terborgh. *Dynamic Equipment Policy*. New York: McGraw-Hill, 1949.

2. As an asset ages, the cost of keeping it in an operable condition increases.
3. As an asset ages, it is moved to less and less productive functions. This “functional degradation” can be illustrated by the two-car family choosing to use the newer model car for cross-country travel and relegating the “old clunker” to short trips around town.

The smart manager knows that an asset should be replaced before its net productivity reaches zero. In fact, an asset should be replaced when the difference between its net productivity and that of a new replacement justifies the purchase of the replacement. *Of fundamental importance to proper replacement strategy is that managers should not ask when an asset becomes worthless, but when it no longer pays to keep an asset.*

The Relevant Costs

Following Terborgh's terminology, I shall refer to an existing asset as the “Defender” and to its potential replacement as the “Challenger.”

Since the acquisition cost of the Defender is an historical cost and thereby sunk, replacement should occur when the net productivity of the Challenger exceeds that of the Defender by an amount large enough to justify the cost of the Challenger. In other words, the acquisition cost of the Defender is totally irrelevant to replacement strategy. This is often difficult for managers to accept until they recognize that a sunk cost is one over which no managerial control can be exerted.

While Defender acquisition costs are not relevant to the replacement decision, two other types of costs are. One of these relevant costs may be thought of as the operating cost of *not having* the replacement, i.e., the cost of retaining the Defender calculated in view of the potential cost savings or increased output of a Challenger. Terborgh calls this difference between the annual cost of the Defender and the

Challenger the “Defender’s operating inferiority,” see Figure 1.

Suppose the annual operating costs (excluding depreciation) associated with the Defender and the Challenger are those shown in Figure 1. We will assume that both machines are equally capable of performing a given task.

Figure 1
Annual Operating Costs

	Defender	Challenger	Difference
Labor	\$10,000	\$ 8,000	+\$2000
Downtime	\$ 3,000	\$ 1,000	+\$2000
Taxes	\$ 200	\$ 400	-\$ 200
Insurance	\$ 100	\$ 300	-\$ 200
Maintenance	\$ 1,000	\$ 500	+\$ 500
Annual Cost	\$14,300	\$10,200	

Defenders Operating Inferiority	+\$ 4,100
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The question now becomes, “Does \$4,100 per year justify the purchase of the Challenger?” Yet this question is oversimplified because there is another relevant cost associated with the retention of the Defender.

Although Defender acquisition costs are sunk (and irrelevant), current and future Defender salvage values are not. Retention of the Defender through the present time period (a year), therefore, involves: a) the decline in salvage value during the period the Defender will be retained, and b) loss in interest on the current salvage value (had it been sold). If, in our example above, the Defender had a current salvage value of \$3,000, an expected salvage value of \$2,200 a year hence, and the firm incurred a 10 percent cost of capital, the total cost of not replacing becomes:

Operating Inferiority	\$4,100
Salvage Loss (\$3,000-\$2,200)	\$ 800
Loss of Interest (\$3,000 x 10%)	<u>\$ 300</u>
Total Annual Cost of Retention	\$5,200

The Time Horizon

In our illustration, above, the decision to replace or not to replace now is based on next year's costs. These are, however, two occasions when the time horizon should be lengthened beyond one year.

First, if the manager expects the acquisition price of the Challenger to rise over time (perhaps due to inflation), then one cost of retaining the Defender is the annual cost of the added Challenger acquisition price. For example, if the current acquisition price for the Challenger is \$10,000 (10 years life and 0 salvage value) and is likely to rise to \$15,000 next year, the annual cost of retention (next years cost of the Defender) becomes:

$$\begin{aligned} & \$5,000 \times \text{Capital Recovery Factor}^{**} \quad .. \\ (n=10, i=10\%) & = \$5,000 \times .16275 = \$814 \end{aligned}$$

Second, the heavy users of technical equipment know that innovations come sporadically. It is likely that the managers of these firms are aware of likely future developments. The hint of a major technological breakthrough may justify several years delay in the replacement decision.

** The \$5,000 is the difference between the current and next year's asset acquisition price. The Capital Recovery Factor for a ten-year (n) period at ten percent

interest (i) is determined by the formula $\frac{i}{1 - (1+i)^{-n}}$

and can be found in most mathematical tables. Its meaning is consistent with the simple amortization of the asset costs over its useful life.

The Decision Model

The preceding discussion assumed that an asset's useful life could be accurately estimated and that the Challenger-Defender advantage over time could be determined. In fact, in the real world both of these items are most difficult to obtain.

It is most difficult to determine that the replacement of a Defender with a Challenger will save \$4,100 (our example) in operating costs *next year*. For an extended time horizon, we know only that the Challenger's superiority will be eroded, i.e., an important cost of accepting a Challenger is its decline in net productivity relative (not to the now forgotten Defender) to the stream of progressively better replacements for it. In other words, an ever-present cost of an acquisition on Monday is that a better choice will appear on Tuesday.

Our suggested decision model requires only that next year's net operating cost for both Defender and Challenger be determined. In addition, one must agree that the operating inferiority will affect the Challenger over time in much the same fashion that it affected the Defender, i.e., as a result of physical deterioration, the net productivity of the Challenger will also decline. Given a rate of decline in the Challenger's net productivity, the optimum life of the Challenger will, therefore, be a period such that the total annual average cost is minimal. The annual decline in the Challenger's net productivity shall be called the "gradient." "Accumulated inferiority" is defined as the difference between the net productivity of an asset in a given year and its net productivity at the time of purchase. Since operating inferiority during the year of purchase is, by definition, zero, operating inferiority in year n is $g(n-1)$ where g refers to gradient, e.g.:

Year	Operating Inferiority
1	0
2	g
3	<u>2g</u>
Accumulated Inferiority	3g

Average inferiority over three years is $3g/3 = g$ and, by algebraic induction, it can be shown that for any period of n years, annual average operating inferiority will be $\frac{g(n-1)}{2}$. In

addition to accumulating inferiority, one must consider the challenging asset's annual capital cost. In the absence of an interest rate, annual capital cost would be:

$$\frac{\text{Acquisition Cost} - \text{Salvage}}{\text{Year of Use}}$$

However, as will be shown later, some consideration must be given to the amortization of this cost over years of use.

An Illustration

On page 2, it was determined that the total annual cost of retaining the Defender, excluding the possibility of a change in the asset acquisition price, was \$5,200. As shown in the above discussion, there are also costs associated with acquiring the Challenger. The costs of acquiring the Challenger can now be calculated and compared with the costs of retaining the Defender to reach the correct replacement decision. Our objective will be to illustrate a replacement decision based on minimizing an asset's total annual average cost.

Suppose the challenging asset has a current purchase price of \$10,000, no salvage value, and a gradient (g) of \$300, i.e., its net productivity declines by this amount per year. Using an interest rate (i) of 10 percent, Figure 2 is constructed to determine the total annual average cost of the Challenger.

A	B	C	D	E	F	G	H	I
Year	Accumulated Inferiority Each Year	Present Worth Factor	Present Worth of Inferiority	(10% Interest) Present Worth of Inferiority Cumulated	(10% Interest) Capital Recovery Factor	Annual Average Cost of Inferiority	Annual Average Capital Cost	Total Annual Average Cost
	\$		\$	\$		\$	\$	\$
1	0	0.9091	0	0	1.1000	0	11,000	11,000
2	300	0.8264	248	248	0.5762	144	5,762	5,906
3	600	0.7513	451	699	0.4021	281	4,021	4,302
4	900	0.6830	515	1,214	0.3155	383	3,155	3,538
5	1,500	0.5645	847	2,806	0.2296	636	2,296	2,932
7	1,800	0.5132	927	3,730	0.2054	765	2,054	2,819
8	2,100	0.4665	980	4,710	0.1874	873	1,874	2,747
9	2,400	0.4241	1,018	5,728	0.1736	997	1,736	2,733
10	2,700	0.3855	1,041	6,769	0.1628	1,102	1,628	2,730
11	3,000	0.3505	1,052	7,821	0.1540	1,204	1,540	2,744
12	3,300	0.3186	1,051	8,872	0.1468	1,300	1,468	2,768

Column B. Figure 2, is simply the accumulated inferiority (\$300 per year) in each assumed year of use, i.e., $g(n-1)$. Column C is the present worth factor^{***} which, when multiplied by the item in Column B gives us the present worth of the accumulated inferiority (Column D). Column E is simply Column D cumulated, i.e., the present worth of inferiority in year n plus the present worth of inferiority in all previous years. Column F is the Capital Recovery Factor which, when multiplied by items in Column E results in the annual average cost of inferiority, (Column G), i.e., as discussed earlier, this produces an amortization of each year's cost of inferiority over the useful life of the asset. The acquisition cost (\$10,000) is also amortized over useful life to produce the entries in Column H, i.e., annual average capital cost is determined by amortizing at 10 percent interest the acquisition cost of \$10,000 over n years, or $\$10,000 \times \text{Capital Recovery Factor}$. Entries in Column H and G are added together to produce the total annual average cost of the Challenger (Column I). You will note decreasing total annual average costs through the tenth year (\$2,730), after which they begin to rise. This minimum is often referred to as the "adverse minimum" and becomes the critical element in our replacement decision model.

If the adverse minimum of the Challenger is less than next year's total cost of the Defender, then the Defender is replaced; if it is higher, the Defender is retained. In our example, the \$2,730 versus \$5,200 dictates that the Defender be replaced with the Challenger. In neither case does the expected life of the Challenger play an important role in our decision. Expected life, while important in deciding depreciation policy, is no longer critical to the replacement decision. If one is willing to recognize this

*** Present Worth Factor = $\frac{1}{(1+i)^n}$ and represents the

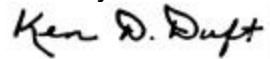
present worth of \$1 to be spent in the n th year. Hence the \$300 inferiority cost in the second year has a present worth of \$248, or $\$300 \times .8264$.

conceptual relationship, asset replacement in the agribusiness industry need no longer be plagued by guesswork and intuition.

Summary

From a practical standpoint, a firm's assets are not immortal. Because of physical deterioration or obsolescence, assets must be replaced. Moreover, the replacement decision is critically important to the success of an agribusiness firm. Either belated or premature replacement will have an adverse effect on the firm's operating costs. This paper reviews asset replacement strategy and develops a decision model for use by agribusiness managers. This paper shows that an asset's expected useful life and the purchase price of an asset in current use are not critical to the replacement decision. Other costs, i.e., the defending asset's operating inferiority and the challenging asset's adverse minimum, are shown to be relevant and critical to the correct replacement decision.

Sincerely,



Extension Economist