EXHIBIT 6 1

A DYNAMIC EQUIPMENT POLICY FOR AMERICA

(AN EXCERPT)

MACHINERY AND ALLIED PRODUCTS INSTITUTE
221 North La Salle Street
Chicago

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Machinery and Allied Products Institute

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PREFACE

The policies of industrial management in the depreciation and replacement of productive plant and equipment are obviously of vital interest to machinery manufacturers. But they are also of wider significance. They affect the tempo of progress, the rate of improvement in living standards, the vigor and vitality of our economic system. Over the long run, they influence profoundly our competitive position in international trade, and even more importantly, our relative status as a great power. They constitute, in short, a question of national policy.

It is doubly fitting, therefore, that the Machinery and Allied Products Institute, a federation of trade associations in the industrial equipment field, should concern itself with this problem. Its activity in the field is in fact of long standing. In 1935, only two years after its founding, it appointed a Committee on Reserves for Rehabilitation, which labored diligently in the preparation of recommendations on depreciation reserve policy for industrial management. The latest revision of these recommendations was published in Bulletin 183, of May 4, 1940. In addition to this notable contribution to the cause of sound depreciation policy for management, the Institute has exerted its influence toward a proper treatment of depreciation for tax purposes, its efforts in this field being devoted chiefly to four main issues: (1) Treasury policy embodied in T. D. 4422 and Mimeograph 4170, (2) the limitation on losses incurred in the sale or exchange of depreciable assets, (3) special amortization of defense facilities, and (4) accelerated depreciation.

As time went on, and as the Institute developed increasing familiarity with the issues of depreciation and replacement policy, it became evident that practical discussions on many points must remain cloudy and inconclusive for lack of basic theoretical grounding, and the decision was reached to make the next project in this field a fundamental analysis calcu-

lated to make good this deficiency. The research staff inaugurated this study in 1943, issuing during that year two preliminary reports, *The Short Payoff in Machinery Replacements* and *Investment Earnings vs. Cost Savings in Machinery Replacement* (Research Memoranda Nos. 1 and 2).

Before the work had progressed far, however, it was set aside in favor of a project deemed even more urgent, an analysis of the doctrines—or as it now appears, the mythology—of economic maturity. This undertaking was completed in June of last year with the publication of *The Bogey of Economic Maturity*, a book that has had already a profound influence on the thinking of economists and laymen alike.

This task done, it was possible for the staff to resume the study of depreciation and replacement, which is now advanced to the point of writing. Normally the Institute would withhold publication of any part of an extended work until the completion and release of the whole, but in this case the introductory chapter of the book, to which these remarks are by way of preface, has seemed so interesting and significant that it has been decided to print it in pamphlet form with the understanding that it is still a preliminary version. We believe that it augurs a very important contribution to the literature of this subject.

The author is our Director of Research, George Terborgh, whose recent contributions to the list of Institute publications include such outstanding works as *An Appraisal of the Fatalistic View of Capitalism* and *The Bogey of Economic Maturity*, already mentioned. As usual, he is assisted by our Executive Committee and by a Special Committee appointed for the project. Both committees review the manuscript as written and contribute their knowledge and experience, making the final result an official Institute product.

WILLIAM J. KELLY
President

March, 1946

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Excerpt from forthcoming book entitled:

A DYNAMIC EQUIPMENT POLICY FOR AMERICA

By

GEORGE TERBORGH

The transiency of human life has been a favorite theme of poets and philosophers since the dawn of history. Less poignant, but no less evident, is the transiency of man's handiwork. Of all the structures and artifacts of Antiquity, only an infinitesimal remnant survives today—a few roads, bridges and aqueducts, a few monuments and temples, a few statues and pieces of pottery, some coins. Of the tangible products of the Middle Ages, not much remains save castles, cathedrals, and monasteries. Physical survivals from later eras are of course more numerous and varied, but save for the vintage of very recent periods they represent but a tithe of the "durable" goods originally produced. The life of most such goods falls far short of the three score years and ten the psalmist has allotted the human span. Indeed, in the United States at least, a typical year's output of durable commodities and structures has an average life expectancy less than half as long.[1] The hand of Time lies heavy on the works of man, whether ancient or modern.

This is a fact, obviously, of the most practical consequence. It confronts the owner of these nominally "durable" but nevertheless ephemeral goods with two problems. The first is to distinguish the quick from the dead; in other words, to tell whether goods not yet physically exhausted have outlived their economic usefulness, either generally or for the

[1] The term "durable goods" as ordinarily used, and as we shall use it, includes all commodities and structures with a normal service life exceeding three years.

particular function they now perform. The second is to make financial provision against the wastage of durable assets over their service life. The one involves replacement policy; the other, depreciation policy.

Replacement Policy

If all durable goods were like the "wonderful one-hoss shay"—requiring no maintenance, as good as new to the end, collapsing finally all at once in a heap of junk—and if they were not displaced before the end of their physical endurance by improved substitutes, the problem of when to replace them would be as simple as the problem of when to replace electric light bulbs. It so happens, however, that these conditions are rarely met. The majority of durable goods require, during their service life, a flow of maintenance expenditures which as a rule rises irregularly with age and use. Most of them suffer a deterioration in the quality of their service as time goes on. Moreover, in a dynamic technology such as ours, they are subject to the competition of improved substitutes, so that the quality of their service may decline *relative to available alternatives* even when it does not deteriorate absolutely. Where these complicating factors are present, replacement does not await the ultimate physical collapse of the asset concerned—indeed in many cases this point is never reached if the parts are renewed piecemeal as they wear out—but is controlled instead by economic considerations.

We are prone to think of replacement as the filling of a vacuum left by the physical collapse or deterioration of existing capital goods, and hence to underemphasize the dynamic effect of external technological and economic change. Physical deterioration is still an important factor in limiting service life—varying widely in significance from case to case—

MAPI Publications of General Interest

Capital Goods Industries and Price Control . . . . . March, 1946

The Full Employment Bill of 1945 . . . . . November, 1945

Capital Goods Industries and Postwar Taxation . . . . . October, 1945

The Bogey of Economic Maturity (Price: $3.00) . . . . . June, 1945

Postwar Exportation of Capital Goods to Non-Industrialized Areas of the World . . . . . January, 1945

Progress Report on Saving and Investment Study (Research Memorandum No. 5) . . . . . September, 1944

MAPI Accounting Manual (Price: $5.00) . . . . . July, 1944

An Appraisal of the Fatalistic View of Capitalism . . . . . June, 1944

*Disposal of Government-Owned Production Facilities (Research Memorandum No. 4) . . . . . January, 1944

Public and Private Investment After the War . . . . . November, 1943

Selected Statistical Series of Interest to Members Filing Appeals for Relief Under Section 722 of the Internal Revenue Code (Research Memorandum No. 3) . . . . . August, 1943

Investment Earnings vs. Cost Savings in Machinery Replacement (Research Memorandum No. 2) . . . . . July, 1943

The Short Payoff on Machinery Replacements (Research Memorandum No. 1) . . . . . June, 1943

*Capital Goods Industries and War-Time Taxation . . . . . August, 1942

Recommendations for Defense Taxation . . . . . May, 1941

Capital Goods Industries and Federal Income Taxation . . . . . July, 1940

*Depreciation Reserve Policies (Bulletin 183) . . . . . May, 1940

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the ability to earn them. That this synchronization has its merits not only for accounting and control purposes, but also from a tax standpoint—a very important consideration nowadays—needs no elaboration.

We stated in our comments on replacement policy that the present study is neither a treatise on engineering economy nor a manual of procedure and practice. A similar forewarning applies to the portion of the study dealing with depreciation. It is not a discussion of the intricacies of accounting, but rather an exploration of basic theory. Also like the analysis of replacement, it yields as a by-product suggestions for simplified methods and procedures more theoretically correct than the ones now in common use.

It requires some temerity to invade, as this book does, two well-tilled fields of inquiry, in each of which the literature is already voluminous. We do so, not to repeat what others have said, but rather in the belief that the previous tillage of these fields has not gone deep enough. We think a further penetration of the theoretical subsoil is needed. This, at any rate, is our main purpose.

but in the modern world external change must be given even greater weight. With the heightened tempo of scientific and technical progress, capital goods are increasingly pushed out of service, or *dis*placed, rather than merely *re*placed after they expire from physical decay. We have made this point in another context:

> "Capital formation is not a polite game in which replacements meekly and decorously await, like dutiful heirs, the natural death of existing assets. It is a ruthless and cutthroat struggle in which new capital goods rob the function of the old. It is murder by degrees. We may add, parenthetically, that this displacement of function is frequently due to the competition of new goods quite different in character from the old. The function of the horse and buggy was appropriated by the automobile, which dispossessed likewise the electric interurban railway. The airplane displaces the ocean liner. Facilities for manufacturing nylon supersede the silkworm. Not only do the new capital goods differ from those displaced; it is obvious that they often have different owners. An investment by one company, for instance, may in effect replace the facilities of a competitor by reducing or eliminating their function."[1]

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[1] *The Bogey of Economic Maturity*, p. 107, Machinery and Allied Products Institute, 1945.

While facilities in one enterprise may have their function appropriated, or displaced, through the competition of facilities in another ownership, and while it is essential to include this form of replacement, as we have done here, in any broad description of the process of capital formation and retirement, we shall use the term "replacement policy" in a narrow sense to denote the policy of a single enterprise or owner. We are interested in replacement as a problem of management. From this standpoint, the possibility that facilities may be functionally displaced through the competition of better equipment in other hands is simply one of the factors conditioning the internal replacement policy of each enterprise.

Consumers' vs. Producers' Goods

Because of these considerations we said a moment ago that durable goods are usually replaced for economic reasons. In the case of consumers' durables, however, such as houses, passenger automobiles, vacuum cleaners, furniture, or fur coats, the term "economic reasons" is obviously too restrictive. Replacement decisions reflect a varying admixture of motives, a compound of economy, emulation, prestige, artistic satisfaction, conformity to convention. Where these non-economic considerations enter, only the comparative *cost* of the services of existing goods and of possible replacements is an objective question; the comparative *valuation* placed upon such services is decidedly personal and subjective. It is possible to compute for milady the annual cost of owning a new fur coat, but we cannot compute for her the annual value of its use. That is for her to judge. Because of the essentially subjective character of these valuations, replacement decisions for consumers' durable goods are rarely made with a sharp pencil and a set of figures. They get made somehow, by the inscrutable mental calculus implicit in all decisions, without benefit of formulas or equations.

The case is different with durable goods owned and operated for profit. Here the question of when to replace involves a comparison of money flows on both sides of the equation, costs on the one hand, income or earnings on the other. We are dealing on both sides with objective, measurable realities, usually involving an element of estimate and prediction to be sure, but—unlike consumers' valuations—subject to expert judgment and technical appraisal. We may be able to show Mr. Jones that it would be cheaper to trade in his passenger car for a new one every four years instead of every year, but if he replies that it is worth the extra cost to drive a new car all the time, that is the end of the argument.

its equipment".[1] The extraordinarily low rates of depreciation taken in Britain, both for book and for tax purposes, have unquestionably contributed to the technological backwardness of industry in that country, of which British critics have so eloquently complained.[2]

Benefits of Improved Depreciation Policy

It may be argued that since replacement decisions *ought not* to be influenced by the depreciation status of the assets it is proposed to retire, the real remedy lies in securing an acceptance of this principle, rather than in the improvement of depreciation policy itself. We agree that the principle should be emphasized, and that its universal adoption would eliminate any drag on replacement arising from the depreciation status of existing assets, but as a practical matter no such universal acceptance is in sight. Even if it were, moreover, it would not do the whole job. We should still have to reckon with the indirectly deterrent effect on replacement of too small a flow of depreciation accruals, the other, and perhaps even more important, aspect of the problem. Both considerations argue for the improvement of depreciation policy.

Even if this improvement yielded no other benefit than a stimulus to the modernization of productive facilities, it would be well worth while, both in this country and in Britain. That this does not exhaust its advantages, however, we shall demonstrate later. A correct policy yields not only a more accurate accounting of cost and income, but by and large a better synchronization of depreciation charges with

[1] *Economist*, January 2, 1943, p. 17.

[2] For examples of these low rates, see the issue of the *Economist* just cited, p. 18. In comparing them with rates in this country, it must be remembered that they are computed by the declining-balance method. They are applied, in other words, to the written-down or depreciated value, not, as in the United States, to the original cost.

the absence of depreciation life estimates. Here again depreciation policy affects replacement policy.

But this is not all. Replacement is affected in still another way, through the influence of depreciation policy on the supply of funds available for capital purposes, especially on the *timing* of the supply. As already noted, various methods of depreciation differ widely in the time distribution of the total charge over the service life. Methods that concentrate the write-off in the early years of life recover the bulk of the investment sooner (assuming the charge is earned) than methods that concentrate it in the later years, or that spread it evenly, hence they provide an earlier receipt of funds for reinvestment. It follows that a growing economy or enterprise with its depreciable assets falling predominantly in the younger age groups will have consistently a higher aggregate depreciation charge under methods that concentrate in the earlier part of the life span. To the extent that capital expenditures are influenced by the volume of depreciation accruals—and this influence is considerable—depreciation policy becomes an important factor in the problem of replacement.

We may summarize by saying that depreciation policy influences replacement policy directly, through a frequent disinclination to retire assets before the end of their estimated life, especially when they have still a substantial book value, and indirectly, through the impact, on capital expenditures, of differences in the volume of depreciation accruals. The extent of this influence in the United States it is of course impossible to measure, but it must be substantial. In the opinion of competent observers, this is true also in Great Britain, where depreciation policy is held to be "one of the factors—though not necessarily the most important one—which determine the rate at which British industry replaces

"Concerning tastes there is no disputing." If, on the other hand, we can show Mr. Brown, who operates a trucking company, that he will make more profit by using his trucks four years instead of one, he will have to prove that we are wrong or stand convicted of willful stupidity. When the test is dollars and cents, we can talk a common language.

Because of these considerations, we shall confine our analysis of replacement policy largely to durable goods operated for profit—the facilities of producton—often loosely described as "producers'" or "capital" goods. This is not only the principal area in which fruitful discussion of the problem is possible; it is also the area in which policy may become a matter of vital national concern. Since most capital goods are replaced for economic reasons, rather than from physical necessity, there can be wide differences in practice from one enterprise or industry to another. There is no bell that rings when the economic life of an asset expires, either for a particular function or for good and all, nor are there any physical stigmata to distinguish the dead from the living. For this reason it is possible for a country to accumulate a sizeable population of mechanical zombies without being aware of it.

Replacement in Great Britain

That some countries have drifted into this condition we may infer from recent criticism of industrial practice in Great Britain:

> "A veil of secrecy hangs over the efficiency of British industry. There are no efficiency statistics. Even the methods for compiling such statistics have not been fully worked out. Sometimes some corners of the veil are lifted, as by the Report of the Cotton Textile Mission to the United States. The Report caused something

of a sensation. It showed that the gap between American and British production per man hour is not only large, but widening; and not only widening, but widening at an increasing rate."

* * *

"The public has in recent months waked up to the fact that the whole wealth-creating mechanism of the British community is badly in need of a drastic overhaul. Several of the basic industries—one is tempted to say most of them—are badly out-of-date in their productive equipment and methods. An hour of work in Great Britain produces less in material product, relatively to other countries, than it used to, and less than it will have to if the British people are to keep their place among those with high standards of living."

* * *

"British industrialists, with a few notable exceptions, have never been "re-equipment-minded". The general attitude towards plant replacement before the war was to scrap a machine only when it could no longer do the job for which it was originally designed. Only rarely was the question asked whether a new machine could do the job better and more economically than an existing one; or whether a new plant layout involving, say, two new machines instead of three installed, would do the job more economically still."

* * *

"For the moment, now that things have come to this pass, there is no satisfactory solution. Everybody has known this about coal for some years and the only new discovery now is that there are many other industries in the same condition. Moreover, there is only one satisfactory long-term solution, and that is a rapid and dras-

of its prevalence a retarded write-off of capital assets is conducive to tardy replacement. If we are right that the most popular techniques of distributing depreciation over the service life give generally a retarded write-off and high book values, it is obvoius that we have in those methods a drag on the modernization and improvement of our productive facilities that would be obviated by better procedures. To this extent the problem of depreciation methods goes beyond mere questions of accounting practice and acquires a public interest.

The influence of depreciation policy on replacement policy is not limited to the choice of the method for spreading the write-off over the service life; quite as important is the estimate of the service life itself. If the assumed life is too great, even a correct method of charging depreciation will give too slow a capital recovery and result in excessive book values, with the drag on replacement they frequently exert. This drag is not the only unfavorable result, however. It is not uncommon to find, even in enterprises that ignore remaining book value in making replacements, a general feeling that capital assets ought to be kept in commission over the service life assumed for depreciation purposes; hence this period becomes a kind of magnet, drawing replacement policy to it, not rigidly or invariably, to be sure, but with a subtle and persistent attraction.

It must be obvious that insofar as the period of service is influenced by the life span assumed for depreciation purposes, actual lives cease to be a test of the validity of the assumed lives and become instead merely their reflection. In practice, of course, this influence is never unilateral. If the actual lives are modified by the assumed lives, the reverse is true also. What we have is a process of interaction yielding actual lives varying more or less from those that would obtain in

the procedures in widest use in this country have in general a bias toward *delayed* write-off. As a rule, too little is charged during the earlier years of service life, too much during the later years.

If this conclusion is true, it is clearly of interest in a variety of ways. It concerns the cost accountant, since it challenges the time-allocation of depreciation cost under conventional methods. Because it affects the accounting of income (including income for tax purposes) not to mention balance-sheet valuations, it also concerns the financial executive. It should be of at least some interest to the appraisal engineer. But this is not all. Since the delayed write-off of facilities is conducive in many cases to their undue retention, it concerns all officials having to do with replacement, especially the general executive, whose responsibility it is to see that the equipment policy of his company is dynamically effective.

Depreciation and Replacement

Leaving the accounting and financial implications for later discussion, we wish to concentrate here on one aspect of the problem, the relation between depreciation policy and replacement policy. Although writers are by no means unanimous on the point, the prevailing view—with which we agree—is that replacement decisions should not be influenced by the book value, or unrecovered cost, of the asset considered for retirement. Anyone who has sold industrial equipment is aware, however, that this rule is often honored in the breach. Not infrequently there is marked unwillingness to "take a loss" on the disposal of assets with substantial remaining book value, and their replacement is handicapped accordingly.

Right or wrong, rational or irrational, this prejudice exists in many places and must be reckoned with. To the extent

tic increase in the productive efficiency of the industries concerned. At whatever point an enquiry into British economic problems begins, it always ends up at the paramount need for productive efficiency. If the difficulties of this year and next serve to ram that lesson home, they may be the ill wind blowing good. They may even provide the country with a glimpse of the economic peril in which it stands."

* * *

"The first essential is to find out how many of those sick industries there are—how many industries, that is to say, which are incapable of paying an attractive rate of wages, providing proper conditions of work, and at the same time producing on a competitive basis. The second essential is to set on foot a vigorous technical examination of these industries to determine how their productive efficiency can be raised to the necessity level."[1]

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[1] These are the views of the London *Economist,* taken from the issues of March 10, July 28, August 4, and October 6, 1945. They find general support in a recent book by Lewis C. Ord, *Secrets of Industry,* and are confirmed with respect to particular industries in the Foot and Reid reports dealing with British coal mining and the Platt report on textile manufacturing. For a comparison of prewar industrial productivity in Britain, Germany, and the United States, see L. Rostas, *Economic Journal,* April, 1943, p. 39.

We do not wish to imply that these commentators on the state of British industry stress the backwardness of its mechanical facilities as the *sole* cause of inefficiency. On the contrary, they recite a long list of factors, including faulty organization, poor marketing arrangements, restrictive labor practices, cartelization and restraints on competition, inadequate scientific research, repressive taxation, traditionalism, insufficient managerial skill, and so on. Backward equipment policy, though the most important single contributor to low productivity, is thus by no means the only factor in the picture. See the remarkable series of articles on *A Policy for Wealth,* appearing in the *Economist* during August, September, and October, 1944, and later reprinted in pamphlet form.

Consequences of Bad Equipment Policy

We may judge from the purport and temper of these remarks that the failure of industry to recognize the economic demise of its productive facilities and to accord them timely burial can have deplorable consequences for the country as a whole, and may properly become a concern of national policy. This is true not only in the case of Great Britain, heavily dependent on exports to competitive world markets; it applies generally. No country can contemplate with equanimity the failure of its industry to keep abreast of technology. It deprives the state of power and security and robs the citizen of the advance in living standards to which he is properly entitled. When private enterprise develops a predilection for antiques as instruments of production, it can expect sooner or later to come under the critical scrutiny of the state, a consummation already attained not only in Great Britain but in France.

In both of these countries the governments have announced far-reaching schemes to raise the productivity of private industry by a planned effort of modernization. A "task force" or "working party" is to be appointed in each industry for a technical survey of its facilities, organization, and operating practices.[1] These survey committees are to recommend programs of reorganization and plant modernization for their respective industries—with what sanctions and means of implementation it remains to be seen. Certainly in some cases, at least, the sanction will be nationalization if the industry does not bestir itself, and even where this threat is not available some other means of pressure will doubtless be found. Witness the recent statement of Eman-

[1] In Britain this scheme is sponsored by Sir Stafford Cripps, President of the Board of Trade; in France by M. Jean Monnet, Chairman of the Commission for Industrial Modernization. See the *Economist*, August 18 and December 29, 1945.

inflation, and threaten to advance still farther. This issue we propose to re-examine.

The second question, how the total depreciation charge should be distributed over the service life of wasting assets, has certainly not lacked discussion in the American literature. Various methods of distribution, some of them quite dissimilar, have claimed adherents both in theory and practice, though the conventional straight-line, or level, write-off is of course the overwhelming favorite. For certain types of assets at least, advocates may be found even of retirement accounting, which concentrates the entire charge at the end of the service life. From this extreme we range through a gamut of methods—appraisal, broken straight-line, units-of-use, annuity, sinking-fund, declining-balance, sum-of-digits, and others.

Theory and Practice

Unfortunately, the argument over the relative merits of those procedures has gone on in a kind of theoretical vacuum. No one, apparently, has developed the basic theory of depreciation in a form intelligible to the business executive. In the absence of any basic understanding, therefore, the discussion has turned largely on questions of administrative convenience, a fact that accounts in large measure for the popularity of straight-line depreciation. Few employing this or any other method have been aware of its hidden assumptions, its unstated premises, and fewer still have seriously appraised the propriety and rationality of these implicit postulates. On the theoretical level, business has operated in the dark, wherein all cats are black.

We propose in the present study to explore this obscure area in order to develop a theoretical foundation for appraising various depreciation methods. We shall find that

Depreciation allowances, usually computed in the form of reserves, are accrued currently, in accord with an estimate of the service life of the capital assets, in order to allocate the cost of the assets to the production obtained through their use. These accruals are charged against gross income as an element of cost, reducing accordingly the net value at which the assets are carried. When earned, they represent a restoration of the investment to cash, and constitute disbursable funds. When not earned, they simply increase net loss. To offset the current wastage of depreciable assets, therefore, it is not sufficient that the accruals themselves be adequate; they must yield spendable funds.

Principal Questions at Issue

There is no disagreement, obviously, as to the desirability of earning depreciation. The real controversy arises over the problem of what is an adequate charge. This in turn breaks down into two problems: (1) whether the total charge over the life of an asset should equal its original cost or its cost of replacement when retired; (2) how the total charge, on either basis, should be distributed over the service life, in other words the question of *timing*.

For various and quite obvious reasons, American practice has adhered with few exceptions to original cost as the amount to be recovered by depreciation charges. This position has not only the all but unanimous endorsement of the accounting profession; it enjoys the powerful support of the Bureau of Internal Revenue, which uniformly disallows reproduction-cost depreciation for tax purposes. Nevertheless, the question of the proper depreciation base deserves more careful consideration than it has received in this country, particularly at a time like the present when reproduction costs have been substantially advanced as a result of wartime

uel Shinwill, Minister of Fuel and Power, that while it is planned to nationalize only 15 to 20 per cent of British industry "we shall demand of private enterprise that it do its utmost to achieve complete efficiency with the remainder."[1] In effect the British and French governments have warned that private business must achieve efficiency on its own initiative—or else.[2]

American Practice

We are accustomed to consider American industry a model of vigor and enterprise in adopting advances in technology, especially in the improvement of its mechanical facilities. We have the legend of the industrial executive, avid for the very latest productive equipment, discarding unhesitatingly and without compunction the still serviceable tools of yesterday the moment something better comes along. Certainly this idealized picture is not without its counterpart in real life, but it must be acknowledged that such zeal and audacity are far from universal. Our practice may compare favorably, by and large, with practice in other countries, but it nevertheless falls far short of what it should be. We venture to say that if a careful survey were made of the productive facilities in use now or at any other time in American industry it would disclose a sizeable fraction in use beyond the economic life for the function or service performed. This country too has its quota of mechanical zombies.

One reason for this condition—though by no means the only one—is a frequent lack of understanding by business management of the principles properly governing the economic life of a productive facility. There are available, of

[1] Quoted by the Wall Street Journal, January 24, 1946.

[2] To add a curious touch, it is reported that in France "the Communists, who have learned the meaning of productivity from Russia, are now among the most fanatical advocates of a policy of industrial modernization" *Economist*, December 29, 1945.

course, a multitude of "replacement formulas", but unfortunately most of them are too complex for the average executive. Even more unfortunately, they yield widely different results when applied to the same set of facts; hence it is often more difficult to decide which formula is correct than to apply the one selected. For these reasons it is not surprising that elaborate mathematical procedures for timing replacement have only a limited currency in American industry. They yield in practice to a simpler application of "business judgment", aided frequently, in lieu of a more scientific formula, by some simple rule-of-thumb test that happens to be favored by the executive concerned.

Certainly there can be nothing wrong with the application of business judgment to this problem; indeed it is indispensable. No magic formula exists or is in prospect by which decisions in this field can be delegated to a clerk with a slide rule. As we have already remarked, "replacement" is rarely the installation of a new unit of plant or equipment identical with the one removed—if it were only that the clerk might suffice—but is more likely to be the substitution of an improved and often radically different unit or combination of units, the operation being more properly described as a *displacement*. The more dynamic the technology concerned, and the more numerous and varied the alternatives, the less adequately will any mathematical formula fit the case, and the greater must be the reliance on personal judgment.

Since the use of full-fledged replacement formulas is comparatively rare, but the use of conventional rule-of-thumb tests of replaceability very common, it is important to examine those shorthand aids to managerial judgment to see how they compare with more carefully considered criteria. We shall find that the most widely used of these conventional short-cuts—such as the rule that the investment in new equipment must be entirely recovered from cost savings over

a two-year or three-year period—are seriously biased in favor of delayed replacement, thus preserving in use facilities whose economic life has expired. Such palpably unscientific expedients have contributed substantially to the accumulation of obsolete productive facilities.

Many industrial managements make replacement decisions without benefit of either formula or rule-of-thumb. The answer is "hunched", sometimes after much weighing of the pros and cons, sometimes with little more analysis than one might devote to the replacement of a pair of shoes. Whether the decisions issuing in this fashion from the managerial bones are better than those obtained by more formal procedures depends, of course, on the quality of the intuition involved, but we venture the opinion that by and large they tend, like decisions based on the common rules-of-thumb, toward delayed replacements.

If we are right in believing it in the national interest to have a productive establishment as modern and efficient as a sound analysis of comparative costs can justify, it follows that a fresh examination of the principles and theory of replacement policy is very much in order. This book is not a treatise on the making of engineering economy studies, of which there are several already available. It is not a manual of procedure and practice. Rather, it is an attempt to explore more fully than has yet been done the basic theory of the subject. It attempts further to develop some simple tests of replaceability more scientifically acceptable than the conventional rules-of-thumb and less elaborate than the existing mathematical formulas.

Depreciation Policy

We come now to the second problem arising from the ownership of wasting assets, the making of financial provision to offset the wastage, in other words, depreciation policy.

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CHAPTER II

THE NATURE OF REPLACEMENT

We emphasized in the preceding chapter the dynamic character of the replacement process. Capital goods live out their mortal span in an atmosphere of combat, a struggle for life as bitter, as intolerant of weakness, as the tooth and claw of biological competition. In principle, this mechanical warfare surpasses in depravity the carnage of the jungle: the beasts respect their own kind, but machines destroy their own species and others indiscriminately. In principle also, mechanical combat is the more dynamic. The denizens of the jungle enjoy a limited security because of the continuity and stability of the species that prey upon them. However perilous the environment, it has for this reason a measure of predictability. Machines, on the contrary, must defend themselves in a world where new species spring up overnight, where the landscape is never twice the same, where the fitful winds of Change are never stilled.

There is another contrast between biological and mechanical competition. In the former, death strikes suddenly, by violence; in the latter, it comes usually by degrees, through a process that may be described as functional degradation. It is a kind of progressive larceny, by which the ever-changing but ever-present competitors of an existing machine rob it of its function, forcing it bit by bit into lower-grade and less valuable types of service, until there remains at last nothing it can do to justify further existence. A capital good that can no longer hold some useful function against competition is a mechanical cadaver, whether buried or not. By the same token, an asset that has been forced into low-grade service through the expropriation of its original function is dead in part. In the bloodless warfare of machines life is taken, as a rule, by stages.

Functional Degradation

Consider, for a moment, the case of the "wonderful one-hoss shay". This remarkable vehicle ran for a hundred years, as good as new, until it suddenly collapsed, catastrophically, in a pile of junk. Assuming--since the narrative is silent on the point--that the quantity as well as the quality of its services were unimpaired to the end, it is clear that the shay was not replaced functionally until after its collapse. Its demise left a functional vacuum which the successor vehicle filled.

Consider now, by contrast, the life history of a freight locomotive born in 1890. It began in heavy main-line service. After a few years, however, the improvement in available new motive power and the development of the art of railroading made the unit obsolete for that service, which was taken over by more modern power. It was thereupon relegated to branch-line duty where the trains were shorter, the speeds lower, and the annual mileage greatly reduced. For some years it served in that capacity, but better power was continually being displaced from main-line duty and "kicked downstairs" onto the branch lines, and eventually our locomotive was forced out at the bottom, to become a switcher in one of the tanktown yards along the line. But the march of progress was relentless, and in the end, thanks

to the combination of obsolescence and physical deterioration, it wound up on the inactive list. For some years more it lay around, idle most of the time, but pressed into service during seasonal traffic peaks and special emergencies. Finally, at long last, the bell tolled and it passed off the scene to the scrap heap.

While the passing of the one-hoss shay left a functional vacuum to be filled by its successor, the retirement of the locomotive was merely a belated recognition of the fact that it was already dead from a functional standpoint. Its departure created not so much as a ripple in the operation of the railroad. Unlike the shay, which maintained the full integrity of its original service to the end, and which was functionally replaced, therefore, after retirement, the locomotive was replaced while it was still in service. Its final retirement was merely an aftermath of replacement.

Now most capital goods fall somewhere between these two extremes. They suffer a partial displacement of function during their life, with the remainder displaced at retirement. Typically they undergo during their active careers an irregular down-grading of function that reflects this partial displacement. New houses are built for the most part in new neighborhoods and for occupancy by people of above-average income, but as they age, stylistic and technical obsolescence and neighborhood deterioration commonly shake them down into lower and lower classes of occupancy. Automobiles ordinarily pass through two or more hands on their way to the scrap heap, not only rendering progressively deteriorating quality of service but running fewer and fewer miles per year. Production equipment is frequently resold in used condition, occasionally several times, going generally into lower-grade uses requiring less precision and reliability and less continuous service. Even when it is held until final retirement by the first buyer, it tends to gravitate with increasing age into low-precision operations and into discontinuous service, winding up frequently as merely protective, or stand-by, capacity.

The debasement of function over the life of a capital good may be either quantitative or qualitative. That is to say, there may be a decrease in the physical volume of service rendered as the unit ages, or a deterioration in the quality of service, or both. A combination of the two forms of degradation is characteristic of most kinds of movable productive equipment, whereas for buildings and other structures qualitative degeneration is predominant.

For obvious reasons, the measurement of decline in the amount of service rendered--in terms of hours worked or miles run per year, for example--is easier than the measurement of decline in quality, though the statistical material available for either purpose is exceedingly meagre. By way of illustrating the quantitative aspect of service degradation, we have shown in Chart I, below, the decline of service intensity with age for eight items or classes of productive equipment: locomotives, agricultural implements, tractors, buses, passenger cars, trucks, truck tractors, and trailers.

1940 for all dwelling units in the metropolitan areas of the United States, by age groups:/1

Age of structure (years)	Median Monthly Rental Value per Dwelling Unit
Under 10	$42.09
10-20	37.34
20-30	30.05
30-40	26.06
40-50	23.42
Over 50	21.06

The deterioration of the quality of service with advancing age of structure is apparent, dwelling units over 50 years old having a median rental value about half that of new units.

This decline in rentals is due not simply to retrogression from the original condition of the structures and neighborhoods; it registers also dynamic changes in the pattern of demand for housing--affecting style, materials, equipment, layout, location, and surroundings--changes which lower the relative desirability of the older dwellings in comparison with the new. Capital goods are "kicked downstairs" in the scale of service not simply because new facilities are developed that can perform better or cheaper the same service rendered by existing units. The service itself may be outmoded by the progress of the arts or by changes in demand. The forced conversion of livery stables to other uses did not reflect the pressure of better facilities for accommodating horses; it denoted the supersession of the horse by motor vehicles. Qualitative downgrading results not merely from a worsening of the service as compared with what it was when the same capital asset was new, but also a worsening relative to the service--competitive, but often quite different--obtainable from a more modern substitute. The former main-line locomotive is retired to branch-line service, with reduced mileage, not primarily because "she ain't what she used to be," but because better motive power has taken over the big runs.

Thus the war of machines is not merely, or even primarily, a struggle for the privilege of performing a pre-existing function or service, though occasionally this is the only thing at issue; it is a more complex affair in which the improvement of the service itself is often the most effective and lethal offensive weapon. The ability of a challenger to perform a superior function can dislodge an existing asset quite as well as its ability to perform the same function in a superior manner. Both factors combine to intensify the ceaseless aggression of the new against the old, the bloodless brigandage by which existing assets are robbed of their functions and shouldered at last into outer darkness.

What is Replacement?

We have discussed the phenomenon of functional degradation at some length because it must be understood if we are to grasp the essential nature of the replacement process, to which we now turn.

Let us revert to the hypothetical freight locomotive mentioned earlier in this discussion, down-graded during its life from main-line to branch-line duty, thence to a switching yard, and finally to occasional or

1/ Computed from the 1940 Census report, Housing, Volume III, part 1, p. 24.

Committee. The meeting was informed as to the results of numerous conferences held with OPA officials, officials in the Office of War Mobilization and Reconversion, the Administrator of CPA, and with the Director of OWM&R, urging immediate removal of capital goods from price control. The session also heard an outline of the arguments for decontrol of capital goods that MAPI will present before the House Banking and Currency Committee which is considering proposed legislation for extension of the price control act. All present were urged to aid in making MAPI's views understood among machinery producers and to acquaint public officials with the serious problems of capital goods producers under price control.

DEPRECIATION AND REPLACEMENT POLICY

The record of the Institute's work on the subject of depreciation and replacement policy, dating back to 1935, was reviewed by Mr. Terborgh for the information of the meeting. He reported that a major investigation in this field, interrupted in order that "The Bogey of Economic Maturity" might be written, had now been resumed. The results will be incorporated in a book "A Dynamic Equipment Policy for America", which will present important recommendations.

The meeting was informed that the first chapter of the depreciation study would soon be available in pamphlet form and that the document would be of interest to customers of equipment producers as well as machinery manufacturers. The session heard a review of the prewar experiences of German industry with accelerated depreciation, and of other devices that have been used to stimulate equipment replacement.

RENEGOTIATION OF WAR CONTRACTS

On request of the Chairman, Mr. Kushell reported on recent developments on the subject of renegotiation and discussed the treatment of costs and profits occurring in 1946, as set forth in MAPI Bulletin 1771. The meeting heard a report on a conference of MAPI officials with Col. Weaver Myers, Counsel, War Contracts Price Adjustment Board, at which it was indicated that the renegotiation boards will not endeavor to apportion profits realized after December 31, 1945 on the basis of percentage of contract completed prior to that date or deliveries made before December 31, provided the contractor consistently followed accounting methods used in previous renegotiations. Treatment under renegotiation of reconversion costs, retroactive wage adjustments, and escalator payments was also considered.

On the question of the renegotiable status of equipment delivered to private customers after V-J Day, two instances were reported where agreement had been reached on a flat percentage