REPORT OF COMMITTEE ON TRANSPORTATION ECONOMICS

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THE ENGINEERING VALUATION OF HIGHWAY SYSTEMS

A Problem in Public Utilities Valuation

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SYNOPSIS

Highway engineering science is still crude and imperfect in two important branches first, engineering valuation of highways, second, highway accountancy The highway systems constitute a public utility comparable to the railways and surpassing all other utilities in magnitude of investment, yet highway engineers do not know how to ascertain the correct present values of the highway properties nor have they developed any standard system of accountancy

The same general principles of valuation and accountancy developed for other public utilities apply to highway valuation including the rule that all factors affecting value must be given due consideration and such weights as may be just and right, as determined by judgment, not by formula

The physical value of the system may be determined by (1) valuing the land owned and used, (2) determining the original cost new less depreciation, (3) determining reproduction cost less depreciation, giving such weight as is just to original cost and reproduction cost price levels Allowance for preliminary expense and going concern intangible values are matters for research and discussion as is also the working capital of highway systems

The earning values of highway systems can be determined by analyzing the revenues (from property taxes, license fees and fuel taxes), operation costs and annual "actual" depreciation costs

The service-worth values are what their earning values would be if their revenues were just equal to the "reasonable worths" of their total highway services rendered Traffic surveys and research on reasonable worths of different highway services are necessary to determine true service worth values

A standard accountancy system should provide for current depreciation accountancy and include property ledger sheets kept up to date Depreciation of the various property units and / or age groups of like units should be estimated by modern methods

INTRODUCTORY DISCUSSION

Immediately after the World War, the author had the great privilege of assisting actively in the formation of the Highway Research Board

There were two principal reasons for its creation: First, it was clearly evident that many billions of dollars were about to be spent in constructing improved highways in the United States, second, in the face of this enormous impending expenditure, the science of modern highway design, construction and maintenance was so pitifully crude and imperfect that enormous wastes were bound to occur, resulting from sheer ignorance, unless unprecedentedly great, immediate scientific advances could be accomplished by a coordinated national program of highway research It is now most gratifying to know that the Highway Research Board has been wonderfully successful in placing modern highway engineering upon a truly scientific basis The value of the highways we have constructed since 1919 is hundreds of millions of dollars greater than could have been obtained without the scientific highway engineering discoveries made the last 14 years

Nevertheless, present day highway engineering science is still pitifully crude and imperfect in two very important branches First, the engineering valuation of highways, second, highway accountancy

During the last 14 years, the highway engineers of the United States have spent about ten billions[1] of dollars for highway construction alone, yet we do not know, and we have developed no way to ascertain correctly the true present values of the highways which have been built at such great cost

The highways of the United States constitute one of the greatest public utilities in the world, whose cost is more than half that of all the railways in our country, yet we have developed no property ledger system worthy the name for accounting for this tremendously valuable property trusted to the care of highway engineers

The annual highway revenues collected in the United States in the form of road taxes on property, gasoline taxes and vehicle license fees constitute one of the major parts of our crushing tax burdens, yet we have never made the researches necessary to establish a scientific basis for equitable charges for highway services and their equitable division between property taxes, fuel taxes and personal fees, all of which are still determined mainly by legislative whims instead of by just principles

Furthermore, highway engineers have never even developed, much less put into use, any standard system of highway accountancy, the first essential of wise public utility management and regulation Ignorant of recent progress in the scientific treatment of depreciation, present day highway engineers content themselves with wild guesses at annual highway depreciation costs, though they are a very important part of the true costs of highway services

A large amount of carefully planned and executed highway research is still needed to develop the scientific technique necessary for the

[1] Omitting maintenance costs and all but a small percentage of the costs of constructing city streets

correct valuation of highway systems, and for a comprehensive and satisfactory standard system for highway accountancy

HIGHWAY VALUATION A SPECIAL CASE OF PUBLIC UTILITIES VALUATION

It is necessary to realize that our highway systems are great public utilities, of which highway engineers and other officials are the responsible managers, not merely the promoters and builders Already the total investment in the highways of the United States is more than half her railway investment, and surpasses the national investment in nearly every other utility The general principles of valuation and accountancy which have been developed for other public utilities during 50 years of experience, study and litigation apply also to highway valuation and accountancy The fact that highway systems are owned by public corporations (states, counties, townships) instead of by private stock companies does not change their status as public utilities, "endued with a public character"

However, highway system public utilities have certain distinctive characteristics, some of which are The capital invested in highways is partly obtained on public credit which is not dependent on the value of highway property, the different state, county and township highway systems connect and exchange traffic at multitudinous points, there are as yet only inadequate traffic survey records of the amount of highway services rendered by the different highway systems, the charges for highway services are not collected directly, in accordance with scheduled rates for different kinds of service, but indirectly, in the form of property taxes, license fees and gasoline taxes, whose proceeds are distributed arbitrarily between the different systems

GENERAL PUBLIC UTILITY VALUATION PRINCIPLES APPLICABLE TO HIGHWAY SYSTEMS VALUATION

The same *general principles of valuation and accountancy* which have been developed for other public utilities apply also to highways *All* factors affecting value must be duly considered and be given "such weight as is just and right in each case" For valuation, the highways of each state can be divided into systems, such as the one state and the ninety-nine county highway systems of Iowa Each system can be valued separately The first step in valuation should be to prepare a complete inventory, showing all property units

Physical Value The physical value of the property may be determined by (1), valuing the land owned and used, (2) and (3), determining separately the original and the reproduction costs new, including overhead costs, less depreciation, of all other physical property units, (4), giving such weight as is just and right in each case to original cost and to reproduction cost price levels

Intangible Values Whether any, and if any what, allowances should

be made for preliminary expense value, going concern value and for the value of highway easements over lands used but not owned are all still matters for research and discussion

Working Capital The working capital of a highway system is the average amount of *operation* funds kept on hand between their dates of receipt and expenditure

Earning Value The earning value of a highway system is the capitalized value of the actual average annual existing net returns For any one year, *net return = total revenue* (say from property taxes, license fees and gasoline taxes)—*operation costs* (Omitting owners' vehicle operation costs)—*annual "actual" depreciation* Interest is a part of net return, *not* an operation cost

Service-Worth Value The service-worth value of a highway system is what its earning value would be if its total annual revenue were just equal to the total "reasonable worth" of the total annual highway services rendered A large amount of work on traffic surveys and in researches on the reasonable worths of different classes of highway services is necessary before the true service-worth values of particular highway systems can be determined

Standard Highway Accountancy System The American Association of State Highway Officials and other highway organizations ought cooperatively to develop a standard system of highway accountancy, including current depreciation accountancy, and standard property ledger sheet accounts, kept constantly up to date

Determination of "Actual" Depreciation "Actual" depreciation costs are a very important part of the costs of highway services and should be estimated separately for each particular property unit, or age-group of like units, by the modern methods recently developed These modern methods are based on the use of mortality curves in estimating probable service lives, on probable service lives reestimated from time to time during actual service, and on "probable future operation return ratios" which take due account of changes in the annual values of the services rendered by particular units The depreciation determinations are kept adjusted to conform with the reestimated ratios and probable service lives, so that they always check out correct at the actual dates of the retirements of the different units

Doubtless, the most important general valuation principle applicable to highway valuation is the famous "*Smyth v Ames Rule*," that *every* factor affecting value must be given due consideration and "such weight as may be just and right" in each case, as determined by sound judgment, *not* by any "formula" This rule has been upheld by the U S Supreme Court ever since 1898, in an unbroken line of decisions

In these decisions, the U S Supreme Court has consistently rejected both the "*Reproduction-Cost-New-Less-Depreciation*" valuation formula, which would give reproduction cost price levels dominant weight,

and the "*Prudent Investment*" valuation formula, which would give original cost price levels dominant weight

The fundamental basis of exchange value is the "present worth" of *probable* future net returns These probable future net returns are indicated by sound judgment *at the date of valuation*, and are not likely to prove to be identical with the *actual* net returns which the future will bring

All the factors which affect value do so by affecting the *probable* future net returns. The factors which have been either actually enumerated or necessarily implied by the U S Supreme Court are:

1 The *original costs* new, including overhead costs, less depreciation to date, of the *existing* property units

2 The *reproduction costs* new, including overhead costs, less depreciation to date, of the *existing* property units

3 The *earning value* obtained by capitalizing the average present annual net returns.

4 The *service-worth value* obtained by capitalizing the average annual net returns which would be earned if the revenues collected were based on charges for highway services just equal to their "reasonable worths "

5. The *stock-and-bond value*, based on current market prices However highway systems have no stock-and-bond values, for they issue no stocks, and their outstanding bonds, if any, are based on the credit of the public corporations which issued them, not on the values of the highway properties

6 All "*other pertinent factors*," affecting value Such as, for highway systems, the characters of the lands and the communities served (which will affect future traffic), present and probable future business conditions, present and probable future price trends

IOWA HIGHWAY SYSTEMS

For valuation purposes, the highways of each state may well be divided into separate systems, each of which includes all highways owned and administered by a separate public corporation, such as a state, a county, a township For Iowa, these systems and the sums spent for their construction during the years 1919–1932, inclusive, alone, are as follows.

Iowa Highway Systems	Construction Costs during 1919–32, inclusive, alone
1 State System, Primary Roads	$232,542,000
99 County Systems, Secondary and Local Roads	120,414,000
	$352,956,000

No construction costs prior to 1919 are included in the above table, and new construction is still proceeding and will continue a long time, About $8,000,000 on the state system and perhaps half as much on the

county systems are being expended on new construction this year The assessed valuation of Iowa railways this year is $215,000,000, including rolling stock In valuing the highways a large deduction would be made for depreciation, but even so, and without including the $300,000,000 or more invested in the automobiles and trucks which constitute the main part of highway "rolling stock," it is evident that Iowa highways constitute a public utility which already approximates her railways and far surpasses any other of her utilities in magnitude of investment

The records of construction costs, operation expenditures and revenues (from highway property taxes, license fees and gasoline taxes) are separate and distinct for each of Iowa's 100 highway systems, of each of which, separately, it is therefore feasible to determine the original cost value, the reproduction cost value and the earning value

On the other hand, a large amount of work on traffic surveys and a large amount of research upon the "reasonable-worths" of different kinds of highway services are necessary before the true "service-worth" values of any of the systems can be determined

THE PROCESS OF MAKING AN ENGINEERING VALUATION OF A HIGHWAY SYSTEM

The process of making an engineering valuation of any one of Iowa's highway systems might well be about as follows

1 Make a complete inventory of all highway property units and/or age groups of like units

There should be in every state, but at present are not in any state, complete highway property records, kept constantly up to date, on standard property ledger sheets, from which a classified inventory for each highway system condensed into valuation groups, can readily be prepared without extensive field work

Physical Value

2 Determine the value of the *land owned and used* This will be a small part of the land *used*, over most of which the public owns only a highway *easement* By the "law of the land," as repeatedly laid down by the U S Supreme Court, the value of the lands owned and used is equal to the *present market value of similar adjacent lands*

3 Determine the *original costs new, including overhead construction costs, less total actual depreciation to date*, of all *present existing* physical property units except land

In doing this, quite a number of omissions in the early records must be supplied by the valuator from his knowledge of cost levels prevailing in past years

4 Determine the *reproduction cost new, including overhead construction costs, less total actual depreciation to date*, of all *present existing* physical property units except land

In doing this the valuator may use "spot" reproduction cost prices, the average for the current year, or the "period" reproduction cost prices which he forecasts for a period of 3 to 5 future years [1]

5 Determine the *total present physical value* of the property of the system, by giving original cost and reproduction cost prices level the relative weights which are judged to be "just and right" in this case, in view of present and forecasted future price trends

Intangible Values

6 Determine whether any, and if any what, *intangible values* should be allowed for (1), *preliminary expense value;* (2), *going concern value,* (3), *highway easements, over lands used but not owned*

In general the courts allow the above intangible values for other public utilities, but research and study are needed to determine what should be the practice in valuing highway systems, owned and operated by the public, especially in cases where the revenues collected are insufficient to pay a "fair" net return profit above the actual costs of the highway services rendered

Working Capital

7 Determine the *working capital* required for the operation of the highway system It is equal to the *average* amount of *operation* funds *necessary* to keep on hand to pay operation cost expenditures promptly

Earning Value

8 Determine the *earning value,* if any, of the highway system The earning value is the capitalized value of the actual, present, average annual net returns The equation for calculating the net return for any one year is

Net return = total highway revenue — total operation costs (interest is *not* an operation cost) *— total annual "actual"* depreciation

Interest on capital indebtedness (such as bond interest) is a part of net return Owners' vehicle operation costs must be omitted.

In general, public utility earnings are subject to regulation, down or up, until they are just sufficient to yield a "fair net return" on the "fair value" of the property owned and used in rendering the services, *provided*[2] that this fair net return does not require charges for the services greater than their "reasonable worths"

Hence, to give material weight in valuation to the "fair net return

[1] In the past the average prices of the last 3 to 5 years have often been used, but should not unless they are believed to forecast the future correctly

[2] In the Smyth v Ames decision the U S Supreme Court said "What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience On the other hand, what the public is entitled to demand is that no more be exacted from it for the use of a public highway than the services rendered by it are reasonably worth "

on fair value" of public utility properties would throw the valuator into a "vicious circle of reasoning"

Highway systems are public utilities, owned and operated by the public for the purpose of affording adequate and satisfactory highway facilities for vehicles owned and operated by citizens, not by the utility The question of how large, if any, excess of highway revenues should be collected above the actual operation cost plus depreciation costs is as yet unsettled, and is worthy of extensive research, study and discussion

Service-Worth Value

9 Determine the *service-worth value* of the highway system, as nearly as may be The service-worth[2] value is what the earning value of the system would be if its total annual revenue were just equal to the total "reasonable worths"[2] of the total annual highway services rendered

In order to determine the service-worth value of a highway system, it is necessary

First, to conduct *traffic surveys*, in order to determine, as nearly as may be, the annual amounts of highway services of different classes rendered by the different component roads of highway systems

The traffic surveys may demonstrate that some unwisely planned, individual roads do not now and are not likely in the future to render highway services commensurate with their costs

Second, to determine the "reasonable worth,"[2] per unit, of each different class of highway services

In some few cases (such as present street railways) the "reasonable worths" of public utility services may be fixed by competition, but in the majority of cases, including most present highway systems, their "reasonable worths" are the costs at which the users could supply themselves with the same services, as organized corporations, not as individuals[3] The application of this principle to highway systems would make the total "reasonable worths" of their annual highway services just equal to the sum of their annual *operation costs* (omitting owners' vehicle operation costs) plus their annual *"actual" depreciation cost* plus their annual *"fair" net returns*, after eliminating any roads which the traffic surveys show to have been unwisely planned

The distribution of the total "reasonable worths" of the system's annual highway services between the different classes of such services requires a large amount of study and research not yet made This is an important subject for new highway research, and for much study and discussion. The following discussion is to be considered as tentative and suggestive only, not as stating final conclusions by the author

A tentative classification of highway services might be

(1) *Road access* highway service This service is direct to the *land*

[3] See *Brunswick & Topsham Water District v Maine* Maine Supreme Court 99 Me 371, 59 Atl 537, December, 1904

owners of adjacent properties; and justifies, in principle, the customary road taxes on lands All classes of roads, primary, secondary, local and by-, render this land access service

It is tentatively suggested that the total "reasonable worths" of the annual road access highway services of the highways within a region are the annual yields of road taxes on lands just sufficiently high to pay the major part of the total annual *operation costs* (omitting owners' vehicle operation costs) plus total *actual depreciation costs* plus annual *fair net returns* of a system of local roads coextensive with the actual highways, and of the type found to be most practicable in view of the topography, of the available road materials, and of the character and values of the lands and communities served

(2) *Road use* highway service This service is direct to *road users*, and justifies, in principle, the customary vehicle license fee and gasoline tax charges for road use The vehicle license fee is a form of "ready to serve charge", while the gasoline tax is probably the best approach practicable at present to ton-mile and vehicle-mile road use taxes

It is tentatively suggested that the total "reasonable worths" of the annual road use services rendered by a highway system is that portion of the sum of its annual *operation costs* (omitting owners' vehicle operation costs) plus its annual *actual depreciation costs* plus its annual *fair net returns* left after deducting the "reasonable worth" of its road access highway services, and that this total may be equitably divided between road services on by-roads, local roads, secondary roads and primary roads by suitably taking into account the average actual vehicle-mile and ton-mile costs of each of those road types

A STANDARD HIGHWAY ACCOUNTANCY SYSTEM

The American Association of State Highway Officials, the Highway Research Board and other highway organizations ought cooperatively to develop a standard system of highway accountancy

Such standard systems of accounts are already prescribed by the Interstate Commerce Commission for steam railways, electric railways and telephone companies, and have been developed and are recommended by the National Association of Railway and Utilities Commissioners for electric, water and gas utilities

In accordance with the rulings of the U S Supreme Court that actual depreciation *is* a real production expense, which must be provided for out of annual income before there is any real net return, and in accordance with the opinions now held and so often expressed by so many industrial authorities, the standard system of highway accountancy ought to provide fully for *current depreciation accountancy*, including a *depreciation reserve account* equal at all times to the total accrued "actual" depreciations on all property units, and for complete property ledger accountancy for each unit and/or age-group of like units

It is necessary for privately owned public utilities to make an annual depreciation appropriation out of income, equal to the total "actual" depreciation during the year In highway administration, all that is needed is to make sure that an investment equal to the year's depreciation is made, out of the current income of each year, in highway replacements, highway improvements and/or new highways

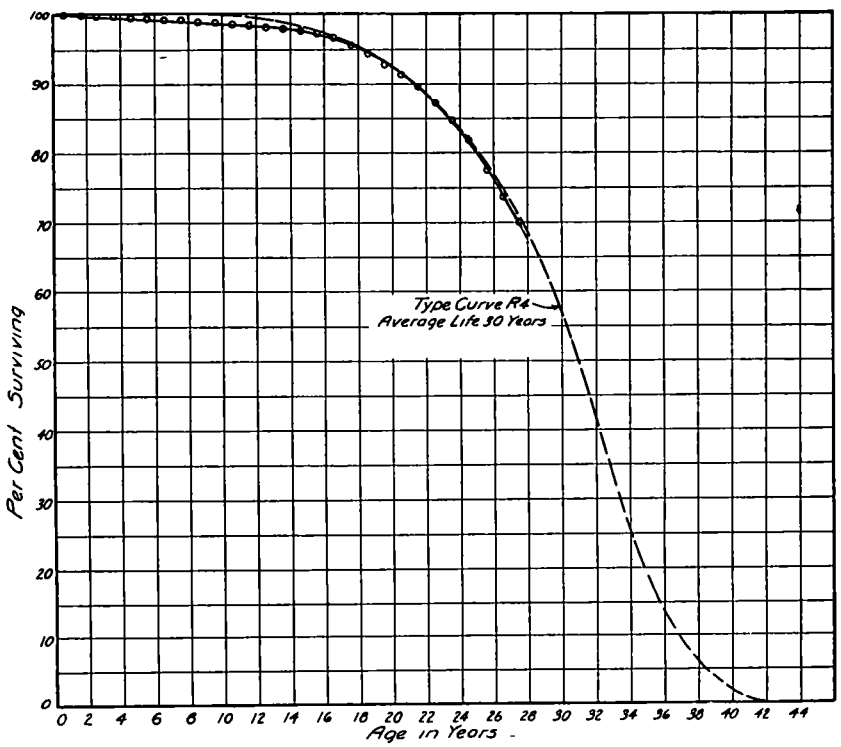

Figure 1 Survivor Curve of Alternating Current Motors by Annual Rate Method

THE MODERN METHODS OF DETERMINING "ACTUAL" DEPRECIATION

It seems not yet to be generally known that during the last ten years entirely practicable modern methods for determining "actual" depreciation have been developed which·

(1) Use mortality curves of different classes of property in estimating probable service lives

(2) By reestimating the probable service life of each property unit and/or age-groups of like units from time to time during service, and immediately afterwards adjusting depreciations accordingly, substitute actual observed service life for guessed average life and make the depreciation determination check out exactly with the value new less actually realized salvage value at the date of the actual retirement of each property unit.

(3) By the use of estimated and reestimated "probable future operation return ratios," enable correct depreciation allowances to be made for changes in the annual values of the services of property units

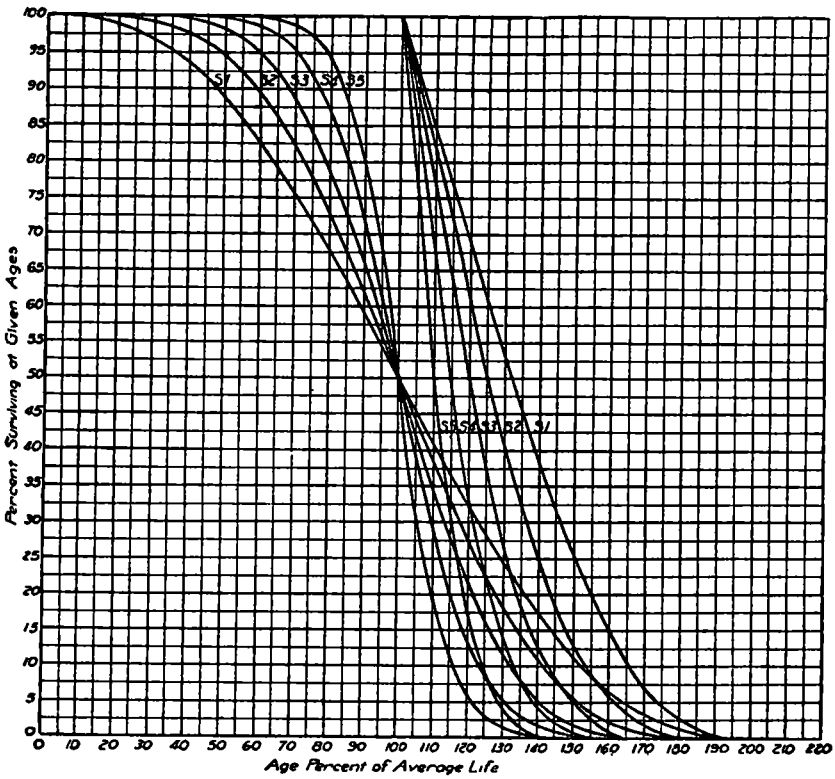

Figure 2 Mortality Type Curves—Symmetrical Mode Group

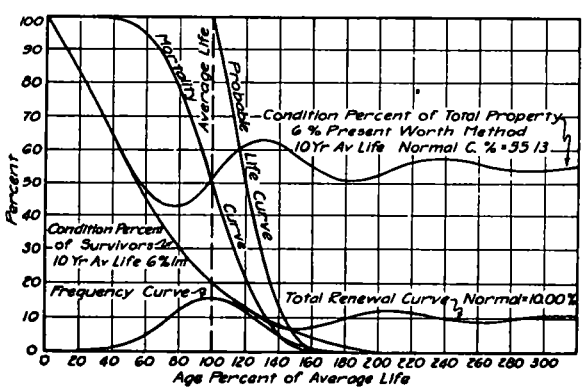

Figure 3 Mortality and other curves for Type Curve S_3

(4) By the use of extensive new "condition per cent" tables make it as easy to base depreciation determinations on the correct "present

worth" of probable future net returns basis of value as on the incorrect "straight line" assumption, that a dollar received as net return at a distant future date is worth today just as much as a dollar on hand today in cash

A very large part of the extensive researches by which these modern depreciation determination methods have been developed has been made during the last 14 years, at the Iowa Engineering Experiment Station, whose Bulletin 103, Life Characteristics of Physical Property, will be sent without charge to all who make request

Figure 1, herewith, shows an actual example of a mortality curve for alternating current electric meters, as determined from eight years records of retirements in a large electric light and power property

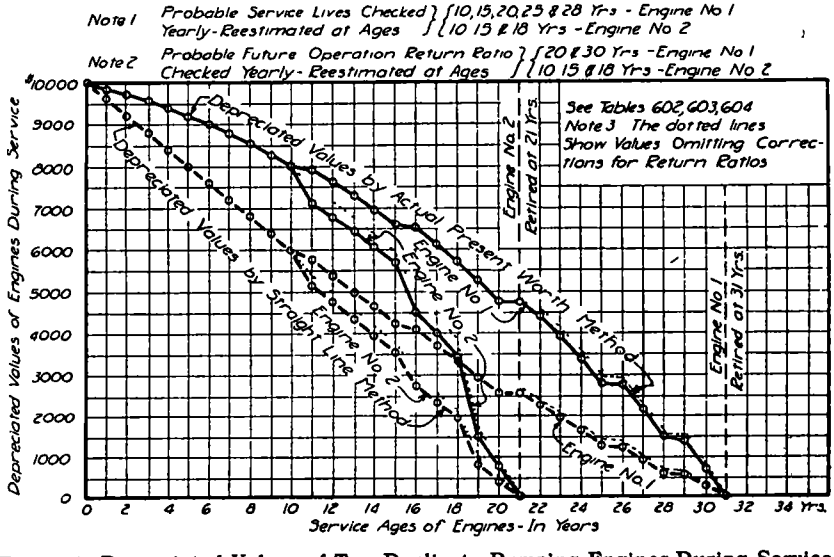

Figure 4 Depreciated Values of Two Duplicate Pumping Engines During Service Showing Actual Depreciations By Actual Present Worth Actual Depreciation Method By Straight-Line Actual Depreciation Method

The Iowa Engineering Experiment Station has developed 13 "mortality type curves," which cover the entire, or nearly the entire, field of mortality characteristics of physical property Four of these are in the "left mode," five in the "symmetrical mode" and four in the "right mode" groups, in which the grestest annual retirement rate occurs respectively *before, at* and *after* ages equal to "average" life In making depreciation determinations, the proper type curve fitting the class of property in question is selected and used

Figure 2 shows the 5 "symmetrical mode" mortality type curves

Figure 3 shows mortality type curve "S_3," the middle curve of the symmetrical mode group

For each mortality type curve, expectancies have been computed by

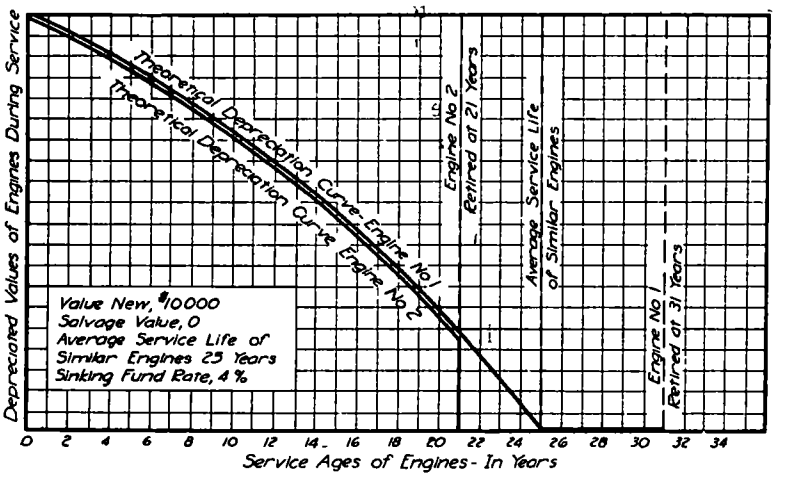

Figure 5. Depreciated Values of Two Duplicate Pumping Engines During Service Showing Theoretical Depreciation By Sinking Fund Theoretical Depreciation Method.

Form 1 — Physical Property Record

SAC COUNTY ELECTRIC COMPANY, SAC CITY, IOWA

Unit — Permutit Water Softener | Location — Power Plant Building | DIVISION — Sac City Power Plant
Manufacturer Crane Mfg. Co. Chicago, Ill | Date Installed Oct. 19, 1929 | ACCOUNT — 315 Miscellaneous Power Plant Equipment
Purchased From Mid-West Supply Co. Des M. | Rating or Size 12,000 gallon per day | ASSIGNED NUMBER — P 321
Mfg's Serial Number 341252x12 | Type Kind, etc — Zeo

DATE	NUMBER IN SERVICE	ITEM	COST STORES	INSTALLATION COSTS	TOTAL COST INSTALLED	ESTIMATED NET SALVAGE VALUE	DEPRECIATION							PRESENT OR RESIDUAL VALUE
							AGE YEARS	LIFE YEARS	REMAINING LIFE YEARS	OBSD PERCENT	F P O R	DEPREC FOR VALUE NEW OF SURVIVORS	ANNUAL DEPR ALLOWANCE	DEPRECIATION RESERVE	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)		(10)	(11)	(12)	(13)	(14)	(15)
10/19/29		Work Order # 306													
	1	12,000 Gallon Permutit Softener	4290 00	310 00	4600 00										
		Piping:													
	10	6"C I B &S	9 65												
	1	6" T Bell	11 00												
	1	6" Gate Valve Bell	24 00												
	176	4" C I B & S	91 80												
	4	4" 90 Degree Bell	19 76												
	1	4" 45 Degree Bell	4 80												
	1	4" T Bell	7 70												
	2	4" Gate Valve Bell	24 00												
	1	4" Float Valve Bell	60 00												
	1	4" x 4" x 2" Y Bell	6 50												
	1	4" x 4" x 2" T Bell	7 15												
	20	2" C I B & S	3 50												
	1	2" 90 Degree Bell	4 50												
	1	2" Gate Valve Bell	7 50												
	22	2½" Steel Pipe Thru Reservoir	8 15												
	2	2½" 45 Degree Elbows	1 70												
		Total Piping	291 40	104 00	395 40										
10/19/29	1	TOTAL WATER SOFTENER	4581 40	414 00	4995 40	0						$ 4 995 40		$	$4 995 40
12/31/29	1	Allocated General Overhead (6 1 %)			304 72							5 300 12			5,300 12
12/31/29						0	0	15	100 0	100		5 300 12	--	--	5 300.12
12/31/30						0	1	15	96 0	100		5,300 12	212 00	212 00	5 088 12
12/31/31						0	2	15	91 6	100		5,300 12	222 61	434 61	4,865 51
12/31/32						0	3	12	82 0	100		5 300 12	819 41	954 02	4 346 10
12/31/33		(City Water Softened)				300 00	4	12	78 2	80		5 000 12	1038 03	1 992 05	3 308 07
12/31/34						300 00	5	12	67 9	80		5,000 12	1310 53	3,302 58	1,997 54
12/31/35						300 00	6	12	60.0	80		5,000 12	197 50	3 500 08	1 500 04
12/31/36						300 00	7	12	57 0	80		5,000 12	-810.00	3 [illegible] 08	[illegible]
12/ 1/37		Work Order # 2178													[illegible]
	1	6" Gate Valve Bell (Retired-Broken)	24 00	10 86	34.86							4,986 56		3,986 56	[illegible]
	1	6" Gate Valve Bell (Replacement)	20 00	10 00	30 00							4 986 56		3 986 56	[illegible]
12/31/37	1	Allocated General Overhead (6 0%)			2 40							4,987 96	44.87	3 986 56	[illegible]
12/31/37						300 00	8	12	49 1	80		4,987 96	990 04	3,525 84	1 772 40
12/31/38						200 00	9	12	33 0	80		5,097.96	563 00	4 088 84	1,209 40
12/31/39						200 00	10	12	22 8	80		5 097 96	313.00	4 400 56	897 40
12/31/40						200 00	11	12	11 9	60		5,097 96	336 46	4 737 02	560 94
10/ 6/41		Work Order # 3063													
		Entire Unit Retired and Salvaged										5,197 96	460 94	5,197 96	100.00
		Sold to John Blank and Co. Chicago. Ill				100 00									
						100 00						$ 5 197 96		$ 5 197 96	0 00

Figure 6

methods like those used by life insurance actuaries, and "probable service life" tables and curves prepared The probable life curve in Figure 3 is an example Also, "frequency" curves, "probable annual renewals" curves, and "average condition per cent" curves as shown in Figure 3 (and corresponding tables) are completed or are in process of completion

A technique has been developed for making actual examinations of property units (without which "actual" depreciation cannot be determined) and of applying the observed data in determining their respective depreciations

Figure 4 shows the results of the application of the modern methods in determining the actual depreciations at different service ages of two entirely similar pumping engines, one of which proved to last 4 years less and the other 6 years longer than the *average* life of similar engines in service

Similarly, Figure 5, shows how the application of "theoretical" depreciation assumptions to the same two engines would give incorrect depreciation determinations, and fail to check out correct at the actual dates of retirement

Finally, Figure 6, shows the latest standard form developed at the Iowa Engineering Experiment Station for the complete property ledger account of a property unit throughout its entire life Similar forms are being developed for the "group" depreciation accountancy of age groups of like units

DISCUSSION

ON

VALUATION OF HIGHWAY SYSTEMS

PROF B D GREENSHIELDS, *Denison University* It seems to me that the rule that all factors affecting must be given due consideration has led to much uncertainty and litigation For this reason would it not be better to use fewer factors in attempting to evaluate a highway system than are used in evaluating other public utilities

The value of a utility based upon the investment cost may be quite different from the value shown by the annual return, the original cost less depreciation may be at variance with the reproduction cost less depreciation Would it not be best to use, say, only the original cost less depreciation than to attempt to bring in other elements which may be conflicting?

DEAN MARSTON By the ruling of the Supreme Court all factors affecting value must be taken into account and each of them must be given such weight as is just and right Original costs are not only to be considered—the reproduction cost is not the only thing In the case

of public utilities, earning value can be given little or no weight since earnings are what are to be regulated, but service-worth value is the value which would be based upon the reasonable worth of the services that must never be exceeded I think the same Smyth v Ames rule applies and should apply to highways There are lots of chances to use your own judgment There are some roads in Iowa, also some road structures, that are not worth what they would cost to reproduce The culverts and grades about to be deserted in making alignments are not worth anything

MAKING AND USING THE TRAFFIC CENSUS

By E W James

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SYNOPSIS

Owing to the present day variety of uses for traffic data the making of a traffic census is a much more complicated operation than the simple count every thirteen days that was started by France in 1844 They are used as bases for construction and maintenance programs, for selection of type and design of pavements, for segregation of routes, for apportionment of revenues, for common carrier rate making, for determining relations between motor vehicle taxes and general property taxes and for many other purposes The cost of a survey planned to yield information on all of the problems is ordinarily prohibitive, so careful advance study is necessary in order that a survey will be certain to yield the particular data wanted Suitable comprehensive forms must be arranged and "details of the master schedule and field organization must be devised with the rigidity necessary to produce regularity of observation, adequacy of supervision and speed in filing field reports, checking for possible errors, and general supervision " However, it must be possible to make quick changes to care for unforeseen contingencies

Since the daily traffic at a station is computed from observations made upon comparatively few actual days during a year and for only a part of those days, it is important that these samples be sufficiently representative to make possible an adequate estimate of the mean daily traffic volumes If the annual traffic is homogeneous and distributed according to the normal probability curve, the standard error in the mean daily traffic can be determined by statistical methods Whether or not traffic is so stable and homogeneous as to afford correct results by statistical analysis has not been fully demonstrated, and therefore studies of such complete statistical universes as those provided by the yearly records of toll bridges or tunnels are advocated

As the French were the leaders both in the art of modern road building and in the science of highway engineering, it is not strange that they should have been the first to develop a traffic census Sometime prior to 1844 the first census was taken, for by that year the French had devised the simple and effective schedule that has characterized